MAT3005

Phase Transformations

Course Outline
Session 2, 2015
Table of Contents

Course staff ................................................................. 2
Timetable ........................................................................ 2
Course Content ............................................................... 3
Detailed Timetable* .......................................................... 3
Assessment ...................................................................... 4
Assignments* ................................................................. 4
Recommended Reference Materials ...................................... 5
Course Information .......................................................... 5
Learning and teaching philosophy underpinning the course .......... 6
Academic honesty and plagiarism ........................................ 7
Continual course improvement ........................................... 7
Administrative Matters ...................................................... 8
Rules for Exams ............................................................... 8

Course staff

Prof. Michael Ferry
Lecturer and Coordinator
Room 341, School of Materials Science and Engineering (Building E10)
Phone: 9385 4453
m.ferry@unsw.edu.au
Consultation hours: by appointment

Dr Jianqiang Zhang
Lecturer
Room 348, School of Materials Science and Engineering (Building E10)
Phone: 9385 5025
j.q.zhang@unsw.edu.au
Consultation hours: by appointment

Timetable

<table>
<thead>
<tr>
<th>Lecture/Tutorial</th>
<th>Day</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture/Tutorial</td>
<td>Monday</td>
<td>14:00 – 16:00</td>
<td>Australian School of Business 216</td>
</tr>
<tr>
<td>Lecture Tutorial</td>
<td>Tuesday</td>
<td>10:00 – 12:00</td>
<td>Webster 256</td>
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Course Content

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. Aspects of ferrous metallurgy and common classes of low carbon and alloy steels to be taught illustrating some of the principles involved.

Detailed Timetable*

<table>
<thead>
<tr>
<th>What you will learn</th>
<th>Week</th>
<th>Assessment task</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PART 1 - LIQUID-TO-SOLID TRANSFORMATIONS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classification of phase transformations. Theory of nucleation in the gaseous, liquid and solid states. Formal theory of transformation kinetics and outline of non-equilibrium transformation diagrams.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Solidification of pure and impure materials - thermal and constitutional super-cooling and their influence on interface stability.</td>
<td>2</td>
<td>Assignment 1 &amp; 2</td>
</tr>
<tr>
<td>Solute redistribution and coring. Eutectic solidification and eutectic structures.</td>
<td>3</td>
<td>Mid-session quiz (week 6)</td>
</tr>
<tr>
<td>Generation of as-cast structures during solidification. Grain refining of cast structures. Casting methods.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Single crystal growth techniques. Zone refining and production of semiconductor materials.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Rapid solidification processing; glass formation and glassy materials. Crystallization of metallic glasses.</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td><strong>PART 2 - SOLID-STATE TRANSFORMATIONS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diffusional and non-diffusional solid-state transformations: nucleation and growth of phases.</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Decomposition of solid solutions; ordering reactions; spinodal decomposition.</td>
<td>8</td>
<td>Assignment 3 &amp; Lab report</td>
</tr>
<tr>
<td>The role of the eutectoid transformation on the formation of pearlite and other diffusional products.</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Bainitic and martensitic transformations; hardenability; tempering.</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Theory of transformation kinetics and the origin of transformation diagrams.</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Aspects of ferrous and non-ferrous metallurgy and common classes of low carbon and alloy steels to be taught illustrating some of the principles involved.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>Final exam</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Topics will be covered on the prescribed week/s unless indicated otherwise.
Assessment

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assignments</strong> – Assignments will include THREE (3) problem sheets provided throughout the course in order to achieve learning outcomes and develop the various graduate attributes. <strong>Due dates:</strong> see below.</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Mid-session quiz</strong> – The aim of this quiz is to assess students’ skills in solving problems concerning solidification processing and its application to materials science and engineering (Parts I). It will consist of a combination of essay-style questions and calculations. <strong>Held:</strong> Week 6, 2 hours</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Laboratory</strong> – The aim is to examine steel phase transformations after heat-treatment. <strong>Laboratory held:</strong> Week 11, 4 hours</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Final exam</strong> – This major exam will cover all aspects of the course consisting of formal lectures, nominated reading material (from course handouts) and assignments. 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. <strong>Held:</strong> Formal examination period, 2 hours.</td>
<td>30%</td>
</tr>
</tbody>
</table>

Assignments*

<table>
<thead>
<tr>
<th>Assignments and Labs</th>
<th>Issue</th>
<th>Submission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1</td>
<td>Tuesday, Week 2</td>
<td>Wednesday, Week 4</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>Tuesday, Week 5</td>
<td>Wednesday, Week 7</td>
</tr>
<tr>
<td>Assignment 3</td>
<td>Tuesday, Week 8</td>
<td>Wednesday, Week 10</td>
</tr>
<tr>
<td>Laboratory Report</td>
<td>Week 11</td>
<td>Wednesday, Week 12</td>
</tr>
</tbody>
</table>

*Each assignment will be issued on the prescribed week unless indicated otherwise.

**Assignment Notes**

All assignments and laboratory report must contain a completed student declaration sheet and will be due in class on the dates specified above. Assignments submitted after the deadline will receive a 10% of maximum grade penalty for every day late, or part thereof. Marked assignments will be returned within two weeks of submission.

Students should note that:

- Prior to selected laboratories, students will receive OHS information (such as risk assessments) and will be required to sign a declaration that they have read and understood this information.
- Appropriate footwear must be worn by students in laboratories at all times. Safety glasses and laboratory coats must be worn in laboratories. Any student not wearing these items will not be permitted in the laboratory and will not be allowed to retake the laboratory at another time and will receive a mark of zero for that laboratory.
Recommended Reference Materials
Reference materials include the following textbook (see below) and other course notes handed out throughout the semester. As indicated below, there are numerous other textbooks concerned with Phase Transformations that students should consult throughout the course.

**Preferred textbook:**


Other suitable books at elementary level:


Course Information

<table>
<thead>
<tr>
<th>Units of credit</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel teaching involved in this course</td>
<td>Nil</td>
</tr>
<tr>
<td>Course objectives</td>
<td>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.</td>
</tr>
<tr>
<td>How the course relates to other course offerings and overall program(s) in the discipline</td>
<td>This course draws on the intellectual framework developed in earlier courses in the program in areas including phase equilibria, diffusion, crystallography, mechanical behaviour, kinetics and diffusion.</td>
</tr>
</tbody>
</table>
| Graduate attributes which will be gained through the course | • Research, inquiry and analytical thinking abilities  
• Capability and motivation for intellectual development  
• Information literacy  
• Ability to communicate effectively  
• Capacity for creativity and innovation  
• Ability to manage information and documentation  
• Ability to function effectively as an individual  
• Capacity for lifelong learning and professional development  
• Professional attitudes |
Expected learning outcomes

Students should gain:
• Enhanced critical thinking, analytical and problem solving skills in materials science and engineering.
• An understanding of the principles underlying liquid-to-solid and solid-state phase transformations in a range of materials.
• An understanding of the importance of phase transformations for controlling microstructure and properties in engineering alloys.

Teaching strategies

• Core concepts, theories and approaches to numerous problems concerning phase transformations will be covered in lectures. Examples will be provided to demonstrate these principles in materials science and engineering. Where appropriate, a number of tutorial classes will be conducted to enhance problem solving skills with incomplete problems given as home work.
• It is expected that students attending classes are prepared for discussion.
• Teaching material, including the course outline, assignments, examples of solutions of problems, and course announcements are available on the Course Vista website.

* Based on the professional attributes given in Engineers Australia National Generic Competency Standards - Stage 1 Competency Standard for Professional Engineers and UNSW Graduate Attributes.

Learning and teaching philosophy underpinning the course

Based on UNSW Learning Guidelines

The course is designed for students to actively engage in the learning process and analyse and synthesise the content in a real world environment.

• **Students are engaged actively 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.
Academic honesty and plagiarism

What is Plagiarism?
Plagiarism is the presentation of the thoughts or work of another as one’s own.* Examples include:

- direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person’s assignment without appropriate acknowledgement;
- paraphrasing another person’s work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle
† Adapted with kind permission from the University of Melbourne.

Continual course improvement

- Students will be asked to provide evaluative feedback through the UNSW's Course and Teaching Evaluation and Improvement (CATEI) process at the end of the course
• Students are encouraged to address any problems regarding teaching of this course at the annual staff-student meeting

• Student comments on teaching during the session are welcome and will be appreciated

At times students may be asked to answer a short questionnaire for feedback on the course

**Administrative Matters**

• Students should attend at least 80% of all classes.

• 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://my.unsw.edu.au/student/atoz/SpecialConsideration.html). Medical certificates or other appropriate documents must be included. Students should also advise the lecturer of the situation.

• Assignments/lab reports submitted after the deadline 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 ([www.studentequity.unsw.edu.au](http://www.studentequity.unsw.edu.au)). Early notification is essential to enable any necessary adjustments to be made.

**Rules for Exams**

Rules governing conduct during exams are given at: [https://my.unsw.edu.au/student/academiclife/assessment/examinations/examinationrules.html - Rulesfortheconductofexaminations](https://my.unsw.edu.au/student/academiclife/assessment/examinations/examinationrules.html)

Note that the use of mobile phones or music players in an exam room will constitute Academic Misconduct.