THE UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF MATERIALS SCIENCE AND ENGINEERING

MATS 4013

PHYSICAL METALLURGY

Course Outline

Session 1, 2008

Course staff

Prof. Michael Ferry Lecturer/ Course Coordinator *Stream 1*	Room: 212 Phone: 9385 4453 m.ferry@unsw.edu.au	Consultation hours: By appointment
Prof. Paul Munroe Lecturer *Stream 2*	Room: 104 (or EM Unit) Phone: 9385 4435 p.munroe@unsw.edu.au	

Timetable

Lecture/Tutorial	Day	Time	Location
Lecture (Stream 1)	Wednesday	09:00-11:00	Webster Theatre A (F Hall A)
Lecture (Stream 2)	Monday (Weeks 1-6)	09:00-11:00	Webster Theatre A (F Hall A)

Course Outline

Stream 1 – Phase Transformations and Microstructure

- Nucleation and growth of a solid from the melt
- Interface behaviour during solidification
- Interface stability
- Solidification of ingots and castings
- Nucleation and growth in the solid state - Role of the interphase interface
- Transformation kinetics
- Non-equilibrium transformation diagrams
- Growth of precipitates
- Eutectoid transformations - formation of equilibrium and non-equilibrium transformation products
- Microstructural development of various ferrous and non-ferrous alloys

Stream 2 – Dislocations and Strengthening

- Introduction
- Resolved shear stresses
- Dislocation theory
- Dislocation motion
- Elastic and energetic properties of dislocations
- Origin and multiplication of dislocations
- Dislocations in f.c.c. materials and b.c.c. materials
- Dislocation interactions
- The effect of dislocations on strengthening.

The learning and teaching philosophy underpinning the course (based on UNSW Learning Guidelines)

- Students are actively engaged in the learning process.
  It is expected that, in addition to attending classes, students read, write, discuss, and are engaged in solving problems in phase transformations and dislocation theory and in the analysis of materials behaviour

- **Effective learning is supported by a climate of inquiry where students feel appropriately challenged.**
  Problems involving **phase transformations and dislocation theory** are challenging; students will be given assignments that will motivate deep analysis of various phenomena in materials science and engineering.

- **Learning is more effective when students' prior experience and knowledge are recognised and built on.**
  The course is built on prior courses in mathematics, mechanical behaviour, phase equilibria and crystallography.

- **Students become more engaged in the learning process if they can see the relevance of their studies to professional and disciplinary contexts**
  Students will be asked to analyse the role of phase transformations and dislocation theory in understanding the relationship between microstructure and properties in engineering materials

Course information

Units of credit	3
Parallel teaching involved in this course	Stream 1 – Phase Transformations and Microstructure Stream 2 – Dislocations and Strengthening
How the course relates to other course offerings and overall program(s) in the discipline	This course will give intellectual framework for a number of materials science courses such as phase equilibria, phase transformation, crystallography, mechanical behaviour, kinetics and diffusion, and others.
Course aims	*Stream 1* The objective of this component of the course is to gain a sound understanding of the role of phase transformations on the development of microstructure and properties in ferrous and non-ferrous alloys. *Stream 2* The objective of this component of the course is to introduce the concepts of deformation, crystal defects and dislocations, and how such defects control the mechanical behaviour of materials.
Graduate attributes which will be	• Research, inquiry and analytical thinking abilities • Capability and motivation for intellectual development

gained through the course	• Communication • Information literacy
Expected learning outcomes	*Students should gain:* • Enhanced critical thinking, analytical and problem solving skills in materials science and engineering • An understanding of dislocation theory and its application to a broad range of materials and materials behaviour • 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 dislocation theory to mechanical properties 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 the dislocation theory and 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.

Assessment	Assignments:	30%
	Combined Mid-session quiz	20%
	Combined final exam:	50%

Assignments will include three (3) problem sheets in stream 1 and one (1) problem sheet in stream 2 in order to achieve learning outcomes and develop graduate attributes.

Assignments		**Issue**	**Submission**
Stream 1	Assignment 1	week 3	week 5
	Assignment 2	week 6	week 8
	Assignment 3	week 9	week 11
Stream 2	Assignment 1	week 6	week 8

Note – All assignments must contain a completed student declaration sheet and will be due on the date specified above. Late submissions will not be accepted without adequate reason in writing. Marked assignments will be returned within two weeks of submission. Requests for special consideration must be submitted using the form available from the Student Desk in the Chancellery and must include medical certificates or other appropriate documents.

Mid-session exam – The aim of this exam is to assess students' skills in solving problems concerning liquid-solid phase transformations and introductory aspects of dislocation theory and the application of these topics to materials science and engineering. It will be conducted in Week 6 or 7.

Final exam – This major exam will cover all aspects of the course consisting of formal lectures, nominated reading material (from course handouts) and assignments and will include a list of equations for stream 1. It will consist of a combination of essay-style answers and calculations. Any derivations will assume knowledge of the material rather than resorting equations to memory with relevant background equations provided.

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.

Recommended Reference Materials

Stream 1

- *Phase Transformations in Metals and Alloys.* D.A. Porter and K.E. Easterling, 2nd edition. Chapman & Hall (1992).
- *Physical Metallurgy Principles*: R.E.Reed-Hill and R. Abbaschian (1992).
- *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).

Stream 2

- D.Hull and D.J.Bacon, *Introduction to Dislocations*, 3rd Ed., 1988
- R.W.K.Honeycombe, *The Plastic Deformation of Metals*, 1968
- G.E.Dieter, *Mechanical Metallurgy*, 3rd Ed., 1988
- R.E.Reed-Hill and R. Abbaschian, *Physical Metallurgy Principles*, 1992
- R.E. Smallman and R. Bishop, *Metals and Materials*, 1996
- R.E. Smallman, *Modern Physical Metallurgy,* 1985.

Continual Course Improvement

- At the latter stages of the course, students will be asked to provide evaluative feedback through UNSW's Course & Teaching Evaluation and Improvement (CATEI) Process.
- Students are encouraged to address any problems regarding teaching of this course at the annual staff-student meeting.
- Students' comments on teaching during the session are welcome and will be appreciated.

Administrative Matters

- Students must attend at least 80% of all classes.
- Students unable to attend the mid-session or final exam on the health grounds should make a rrequest for special consideration by submitting the form available from the Student Desk in the Chancellery. Medical certificates or other appropriate documents must be included. Students should also advise the lecturer.
- 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 convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (9385 4734 or www.equity.unsw.edu.au/disabil.html). Early notification is essential to enable any necessary adjustments to be made. Information on designing courses and course outlines that take into account the needs of students with disabilities can be found at:

  www.secretariat.unsw.edu.au/acboardcom/minutes/coe/disabilityguidelines.pdf