Course: MTLS 3T04
Title: Phase Transformations

Instructor:
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Office Hours:
• Thursday: 11:30 to 1:00 in JHE 357D

Teaching Assistants:
• Mady Bhattacharyya
• Caitlin Dever
• Esther Hutten

Calendar Description:


Three lectures, one lab (three hours); second term

Prerequisite(s): MATLS 1M03, 2D03 and 2X03.

Course Topics:

Week 1: Significance of phase transformations.
Week 2: Review of solution thermodynamics, regular solution model.
Week 3: Use of the common tangent construction, Gibbs Thomson Effect.
Week 4: Crystal interfaces, grain boundaries, grain-growth and recrystallization
Week 5: Diffusion control vs. interface control.
Week 7: Solidification.
Week 8: Diffusional transformations. Spinodal decomposition, homogenous and heterogeneous nucleation.
Week 9: Growth of precipitates. TTT and CCT diagrams. Age hardening.
Week 10: Pearlite and bainite transformations.
Week 12: Tempering of martensite.
Week 13: Review.
Course Objectives:

At the conclusion of this course, the student should be able to:

a. Describe the Gibbs energy of mixing of binary alloys and relate it to the phase diagram.

b. Describe the key features of diffusional and non-diffusional transformations.

c. Describe the processes of homogenous and heterogeneous nucleation.

d. Identify the boundary conditions that operate during a diffusional phase transformation.

e. Understand the factors that control the kinetics of various phase transformations.

f. Describe the role of phase transformations in microstructure development.

g. Apply their knowledge of microstructure development to failure analysis problems.

h. Work effectively in a team.

i. Use modern engineering tools to characterize the microstructure of common engineering materials.

Professional Development:

MATLS 3T04 is an important part of your training as an engineer. In particular:

Items (a-f) will contribute to your specialized engineering knowledge (CEAB attribute 1.4). The failure analysis lab, item (g), will as contribute to attribute 2 (Problem Analysis) and attribute 3 (Investigation). This course will also give you exposure to modern engineering tools, item (i), which is linked to attribute 5 (Use of Engineering Tools). Finally, the team work component of this course, item (h), will contribute to developing your ability to work individually and in teams (attribute 6).

Primary Textbook:


Other useful Resources:

- Hoyt, Phase Transformations
- Shewmon, Phase Transformations in Metals
- Haasen, Physical Metallurgy
- Veerhoeven, Fundamentals of Physical Metallurgy
- Kingery, Introduction to Ceramics
Lectures:

Tuesday, Thursday and Friday at 8:30, BSB 138.

Laboratories:

Laboratories are scheduled every week. The experiments are listed below and described in detail in the laboratory manual:
(A) Solidification and Casting
(B) Pearlite Transformation and Image Analysis.
(C) Microstructure Evolution and Age-hardening.
(D) Failure Analysis

Evaluation:

Lab Participation (A,B,C,D): 10%
Failure Analysis Project 15% (10% for the report and 5% for the presentation).
Tests (2): 30% 1 hour each, February 1st and March 8th.
Final Exam 45% 2.5 hr exam.

* For labs A, B, C and D the student will receive 2.5% for attending the lab, performing the required tasks and participating in the lab discussion with the TA. All students are expected to keep a hard bound lab book in which all lab observations and discussions are recorded. The TA will initial these at the end of each lab.
* The failure analysis lab requires a formal lab report. The report is due on April 9th. The failure analysis presentations will take during lab time on April 6th. Lab reports and presentations should be submitted into the appropriate drop-off box on Avenue. Late lab reports will be penalized 25% per day.
* A peer evaluation multiplier will be applied to the grade of the failure analysis project (presentation and report).

Policy Reminders:

The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem that cannot be resolved by discussion among the persons involved, individual are reminded that they should contact the Department Chair, the Sexual Harassment Office or the Human Rights Consultant, as soon as possible.
The Senate Resolution on Course Outlines states that:

“students should be reminded that they should read and comply with the "Statement on Academic Ethics and the Senate Resolution on Academic Dishonesty" as found in the Senate Policy Statements distributed at registration and available in the Senate Office”.

Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a
notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at: http://www.mcmaster.ca/senate/academic/ac_integrity.htm

The following illustrates only three forms of academic dishonesty:
- Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- Improper collaboration in group work.
- Copying or using unauthorized aids in tests and examinations.

Accessibility:

McMaster University is committed to fostering, creating and maintaining a barrier-free environment for all individuals providing equal rights and opportunities, including:
- Promoting a respectful attitude for persons with disabilities;
- Promoting awareness of the needs and abilities of persons with disabilities;
- Informing the University community about the services available to persons with disabilities and seeking to ensure that such services are delivered in ways that promote equity; and
- Providing support services, subject to certain limitations.

Students requiring service or accommodation contact Student Accessibility Services (SAS): http://sas.mcmaster.ca/ as soon as possible.

For more information, please visit http://mcmaster.ca/policy/Students-AcademicStudies/

Disclaimer:
"The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes."

Completed by: Hatem S. Zurob, January 2018