MTSE 3060
PHASE TRANSFORMATIONS IN MATERIALS
Spring Semester 2011 – 3 credit hours

Instructor: Dr. Raj Banerjee, Office: E-110 Discovery Park
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Office Hours: Walk-in or e-mail to make appointment
Lecture: Monday and Wednesday, 9:30 a.m. – 11:00 a.m.
Location: UNT Discovery Park, Room D208A
Textbook: Phase Transformations in Metals and Alloys by D. A. Porter and K. E. Easterling
Lecture Notes will be posted on website:
http://www.mtse.unt.edu/Banerjee/Courses.html

COURSE INFORMATION

Goals / Learning Objectives: This course will provide the student with an understanding of the basic principles and mechanisms underlying both solid-solid and liquid-solid phase transformations with an emphasis on metallic materials. The objective is to apply the concepts of thermodynamics, diffusion and kinetics, and crystallography (crystal structure and symmetry in materials) to develop a clear understanding of the free energy changes and kinetics associated with various types of phase transformations.

Prerequisites: MTSE 3010 (Bonding and Structure) or equivalent and MTSE 3030 (Thermodynamics and Phase Diagrams) or equivalent

Examinations, Projects, and Grading: There will be two mid-term exams and one final exam. Additional homework assignments will be administered for practice purposes. Tentatively, the overall grading will be as follows.

Mid-term I: 30%
Mid-term II: 30%
Final exam: 40%

Makeup Exam Policy: If a student cannot take the exam on the scheduled date due to some unavoidable circumstances, such as out of town business trip, sickness, etc., then he/she must notify the instructor in writing before the scheduled exam time to schedule a makeup exam.

Class Attendance is Mandatory. Please notify me if you have to miss a class or will be late.

Program Outcome Coverage

(a) An ability to apply their knowledge of mathematics, science, and engineering.
(b) An ability to apply and couple the basic concepts of thermodynamics, diffusion, and crystallography.
(c) An ability to integrate their previous knowledge to real life materials problems related to microstructural evolution and microstructure-property relationships.
(d) An ability to function on multi-disciplinary teams.
(e) An ability to identify, define, and solve engineering problems.
(f) An understanding of professional and ethical responsibilities.
(g) An ability to communicate effectively.
(h) To recognize the need for, and an ability to engage in life-long learning.
(i) To gain knowledge of contemporary issues.

**Academic Integrity** – Plagiarism and cheating will NOT be tolerated. Please see UNT academic manual for the definition of plagiarism. Any student caught cheating will be given an overall **F grade (Fail)**. When in doubt please ask me.

**Topics to be covered**

1. **Review of thermodynamics and diffusion**
   1.1 Review of Thermodynamics
   1.2 Review of Diffusion

2. **Solidification, vitrification, and crystallization**
   2.1 Nucleation in liquids – Homogeneous and Heterogeneous
   2.2 Growth of single component systems
   2.3 Solidification of Alloys
   2.4 Rapidly solidified crystalline products
   2.5 Amorphous metallic alloys
   2.6 Crystallization
   2.7 Solid State Amorphization

3. **Diffusional Transformations in Solids**
   3.1 Nucleation in solids - Homogeneous and Heterogeneous
   3.2 Growth of solid precipitates
   3.3 Overall transformation kinetics – TTT Diagrams
   3.4 Precipitation reactions
   3.5 Phase Separation
   3.6 Cellular precipitation
   3.7 Eutectoid decomposition
   3.8 Massive transformations
   3.9 Ordering Transformations

4. **Diffusionless Transformations**
   4.1 General features of martensitic transformations
   4.2 Martensite crystallography
   4.3 Martensite nucleation
   4.4 Martensite Growth
   4.5 Examples