MSE 3002: Structural Transformations in Metallic and Ceramic Materials (required)

Catalog Description: (3-0-3)
Prerequisites: MSE 3001 Materials Thermodynamics
Introduction and overview of phase changes that can be applied to engineering materials; review of phase equilibria and phase diagrams; definitions of microstructural elements; diffusion and atomic mobility; solidification; diffusional transformations; martensitic transformations; grain growth, sintering and solid state reactions.

Textbook: Phase Transformations in Metals and Alloys, D. A. Porter and K. E. Easterling, 2nd Edition, CRC Press, 1992

References: Notes
"Introduction to Metallurgical Thermodynamics," D. R. Gaskell, McGraw-Hill, 1973

Prepared by: T. H. Sanders, Jr.

Topics Covered:

I. Review of thermodynamics and phase diagrams
(Chapter 1, Porter and Easterling)
The contents of Chapter 1 are essential to every chapter in the text because it contains the fundamental thermodynamics necessary to describe structural phase transformations occurring in all materials. Questions from the topics presented Chapter 1 will appear on all exams, quizzes and homework assignments.

II. Diffusion (Chapter 2, Porter and Easterling)

III. Crystal interfaces and microstructure (Chapter 3, Porter and Easterling)

IV. Solidification (Chapter 4, Porter and Easterling)

V. Diffusional transformations (Chapter 5, Porter and Easterling)

VI. Diffusionless transformations (Chapter 6, Porter and Easterling)

Outcome 1: The student will gain experience in coupling thermodynamic parameters such as Gibbs free energy to develop the driving forces for phase transformations.

Outcome 2: Describe the five key microstructural elements that include: atomic and molecular structure; defects; solute; particles of a second phase; and grain boundaries.

Outcome 3: Describe the role of the microstructural elements with respect to; diffusion; solidification in single and multi-component systems; diffusional phase transformations; and non-diffusional phase transformations.

Course Outcomes	Student Outcomes										
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
1. Student will gain experience in coupling thermodynamic parameters such as Gibbs free energy to develop the driving forces for phase transformations.	x	x							x		x
2. Describe the five key microstructural elements that include: atomic and molecular structure; defects; solute; particles of a second phase; and grain boundaries.	x	x							x		x
3. Describe the role of the microstructural elements with respect to; diffusion; solidification in single and multi-component systems; diffusional phase transformations; and non-diffusional phase transformations.	x	x							x		x
Entire Course	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**3**
0 = None or insignificant; 1 = Some; 2 = Moderate; 3 = Strong											

School of Materials Science and Engineering Student Outcomes:

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice