MTSE 3030 – **Thermodynamics and Phase Diagram**

(Required) Fall Semester

Catalogue data: First three laws of thermodynamics; phase equilibria, phase diagrams, reaction equilibria and solution theory, principles and applications of phase diagrams.

Prerequisites: ENGR 3450, MTSE 3000 or similar MSE introductory courses.

Time distribution: Two 1.5 hr classes per week.

Objectives: To provide students with the ability to a) understand and use the laws of thermodynamics, b) interpret and apply thermodynamics relations and Maxwell's equations, c) read and apply unary, binary and ternary phase diagrams of different types of materials, d) understand binary phase diagram using solution thermodynamics and phase equilibria theory, e) reaction thermodynamics and Ellingham diagram. ABET criterion outcomes 1, 2, 3, 5, 7, 9, 11.

Textbook: Thermodynamics in Materials Science, 2nd edition, Robert DeHoff, CRC Press, 2006. (required)
Introduction to Thermodynamics, 5th edition, David Gaskell, Taylor and Francis, 2008. (reference)

Topics:

1. Importance of thermodynamics in materials science
2. First law of thermodynamics
3. Second law and entropy
4. Heat capacity and the third law of thermodynamics
5. Relationships in thermodynamics and Maxwell's equations
6. Statistical thermodynamics
7. Thermodynamics and phase equilibria
8. Solution thermodynamics
9. Binary phase diagrams
10. Defects and interfacial thermodynamics
11. Ternary phase diagrams
12. Reaction thermodynamics
13. Electrochemistry

Grading plan:

(1)	Homework (4 total) & attendance	100 pts	20%
(2)	Midterm Exam	100 pts	30%
(3)	Final Exam	100 pts	30%
(4)	Course Project	100 pts	20%

Professional Component content:

Engineering Science: 2.5 credits or 83%.
Engineering Design: 0.5 credits or 17%.

Design Component content:

Students learn to apply fundamental concepts of thermodynamics to understand materials in terms of the equilibrium phase diagram, relationships of thermodynamic functions, and chemical reactions. They will learn the underlying mechanisms by which phase diagrams are constructed and apply them to multicomponent homogeneous and heterogeneous phase systems. They will also learn reaction thermodynamics and apply it to practical problems in material processing.

Relationship to program Objectives:

The course is integral to program objectives 1, 2, and 3. It provides students opportunities (1) to understand and apply the concepts of thermodynamics to materials applications, and (2) to recognize new design opportunities with materials and communicate their ideas with their peers.

Prepared by: Ruocun (John) Wang Date: August 10, 2025