MSE 1059: Phase Equilibria in Multi-Component Materials
Syllabus for 2024 Fall

Instructor: Dr. Yingjie Wu (Office: SCUPI Room N405; Email: yingjie.wu@scupi.cn)

Lecture: 3 Credits, Monday, 8:15 am – 11:00 am, LAB Room 4-202
Office Hours: Monday, 1:50 pm – 4:25 pm, SCUPI Room N405
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Prerequisites: PHYS 0174, CHEM 0960

Course Description:

This course provides an in-depth exploration of the principles governing phase equilibria in multi-component materials. It covers the thermodynamic foundations of phase diagrams, including phase stability, phase transitions, and the relationships between phase equilibria and material properties. Students will learn how to construct phase diagrams, analyze phase transformations, and predict phase behavior in complex systems. The course will also introduce computational tools and experimental techniques commonly used in the study of phase equilibria.

Course Objectives:

The goals of this course are 1) to develop a deep understanding of the thermodynamic principles underlying phase equilibria in multi-component materials, 2) to be proficient in constructing and interpreting phase diagrams for complex material systems, 3) to analyze and predict phase transformations in response to changes in temperature, pressure, and composition, 4) to apply computational methods and software tools to calculate phase equilibria in real-world materials, 5) to gain hands-on experience with experimental techniques used to study phase equilibria, and 6) to understand the practical significance of phase equilibria in material design and processing.

Applicable ABET Outcomes:

1. An ability to apply knowledge of mathematics, science, and engineering
2. An ability to function on multi-disciplinary teams
3. An ability to identify, formulate, and solve engineering problems
4. An ability to communicate effectively
5. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Required Resources:

Required textbook:

1. Gaskell, D.R., and D.E. Laughlin. ***Introduction to the Thermodynamics of Materials***. 6th ed., Boca Raton, FL: CRC Press, 2018. Print.

Useful supporting materials:

1. Lewis, G.N. and M. Randall, ***Thermodynamics***, revised by K.S. Pitzer and L. Brewer, 2nd ed., New York, NY: McGraw-Hill, 1961. Print.
2. Kubaschewski, O. and C.B. Alcock, ***Metallurgical Thermochemistry***, 5th ed., Oxford: Pergamon Press, 1979. Print.
3. Schafer, H., ***Chemical Transport Reactions***, translated by H. Frankfort, New York, NY: Academic Press, 1964. Print
4. Smith, J.M. and H.C. van Ness, ***Introduction to Chemical Engineering Thermodynamics***, 4th ed., New York, NY: McGraw-Hill, 1987. Print.
5. Johnson, D.A., ***Some Thermodynamic Aspects of Inorganic Chemistry***, New York, NY: McGraw- Hill, 1953. Print.
6. Darken, L.S. and R.W. Gurry, ***Physical Chemistry of Metals***, New York, NY: McGraw-Hill, 1953. Print.
7. Denbigh, K., ***The Principles of Chemical Equilibrium***, 3rd ed., Cambridge University Press, 1971. Print.
8. Wagner, C., ***Thermodynamics of Alloys***, translated by S. Mellgren and J.H. Westbrook, Cambridge, MA: Addison-Wesley Press, 1952. Print.

Course Content (tentative):

Week	Date	Topics	Reading Assignment	Homework
1	9/2/24	Introduction/ Review on Basic Thermodynamics	Chapters 1-6 & 8	
2	9/9/24	Phase Equilibria in Unary Systems	Chapter 7	Assignment #1
3	9/16/24	Solution Thermodyanmics I	Chapter 9	
4	9/23/24	Solution Thermodyanmics II	Chapter 9	Assignment #2
5	9/30/24	Phase Equilibria in Binary Systems I	Chapter 10	
6	10/7/24	Phase Equilibria in Binary Systems II	Chapter 10	Assignment #3
7	10/14/24	A Deeper Understanding on Phase Diagrams I	Additional Reading Material	
8	10/21/24	Midterm Review		
9	10/28/24	Midterm Exam I		
10	11/4/24	A Deeper Understanding on Phase Diagrams II	Additional Reading Material	Assignment #4
11	11/11/24	Phase Equilibria in Ternary Systems I	Additional Reading Material	
12	11/18/24	Phase Equilibria in Ternary Systems II	Additional Reading Material	Assignment #5
13	11/25/24	Midterm Exam II		
14	12/2/24	Solution Thermodyanmics I	Chapter 13	
15	12/9/24	Solution Thermodyanmics II	Chapter 13	Assignment #6
16	12/16/24	Final Review		
17	12/23/24	Final Exam		

Grading Policies:

Requirements	Corresponding Percentages
Assignments (6)	20%
Midterm Exam I	20%
Midterm Exam II	20%
Final Exam	35%
Participation	5%

Grading Scale:

100% ≥ A ≥ 90%; 90% > A− ≥ 85%; 85% > B+ ≥ 80%; 80% > B ≥ 76%; 76% > B− ≥ 73%; 73% > C+ ≥ 70%; 70% > C ≥ 66%; 66% > C− ≥ 63%; 63% > D ≥ 60%; 60% > F.

Homework:
There will be about ten homework assignments that will be submitted to Blackboard either as Word document or as pdf ***before the start of the class (8:15 am) on the due day***. If you are unable to attend a class, you may attach a note to your homework and submit it in advance. ***If homework is submitted late, you would lose 10% per day. You may receive no credit if homework is not submitted within a week from the due day.***

Exams:
There will be a midterm exam and a final exam in this course. An equation sheet might be permitted (information about this will be given a week before the exam). The students need to be present during the exam. In case of an emergency (doctors notice), a make-up exam might be given. The only allowed things during the exams are electronic calculators and writing and drawing instruments. Paper and the exam sheet will be provided. Other computational tools, such as mobile phone, are not allowed.

A student found ***cheating***, ***attempting to cheat***, having an ***unauthorized device/tool*** during the exam ***independent of the reason*** will receive a zero on the exam.

Participation:
Participation through presence but also answering questions, asking questions, contributing to activities is very important to improve active learning for each student. Therefore, your participation will be graded during each lecture starting with the second week.