

## **MSE 6401A/6401B: THERMODYNAMICS OF MATERIALS**

Fall Semester, 2013

Objective: To examine the principles of thermodynamics as applied to equilibria associated with solutions, mixtures, and chemical reactions in materials.

Instructors: *Prof. Ken H. Sandhage* (MSE 6401A/MSE 6401B; MSE 6501A)  
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### Teaching

Assistant: *Ben deGlee*  
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### Class Hours/

Location: Tues., Thurs. at 12:05-1:25 pm. 299 Love Building.

Office Hours: Sandhage (6401A, 6401B, 6501A): Tuesdays, 4:00-5:00 pm  
Bucknall (6501B): By appointment

Textbook: None (handouts provided)

### References:

Primary: "Chemical Thermodynamics of Materials," C. H. P. Lupis, North Holland, 1983  
"Thermodynamics, Kinetic Theory, and Statistical Thermodynamics," F. W. Sears, G. L. Salinger, Third Edition, Addison-Wesley Publishing Co., 1975  
"Alloy Phase Equilibria," A. Prince, Elsevier Publishing Co. 1966  
"Polymer Phase Diagrams", R. Koningsveld, W. H. Stockmayer, E. Nies, Oxford University Press, 2001  
"Concepts in Polymer Thermodynamics, M. A. van Dijk, A. Wakker, Technomic Publishing Co, 1998"

Secondary: "Thermodynamics in Materials Science," R. T. DeHoff, McGraw-Hill, 1993  
"Introduction to Metallurgical Thermodynamics," D. R. Gaskell, McGraw-Hill, 1973  
"Polymer Physics," M. Rubinstein, Oxford University Press, 2003  
"Soft Condensed Matter," R. A. Jones, Oxford University Press, 2002  
"Thermodynamics of Solids," R. A. Swalin, Wiley & Sons, 1972  
"The Principles of Chemical Equilibrium," K. Denbigh, Cambridge Univ. Press, 1971

Grading:

MSE 6401A:	Quizzes:	16%
(Sandhage)	First Exam:	25%
	Second Exam:	25%
MSE 6501A:	Quizzes:	9%
(Sandhage)	Third Exam:	25%
	Total:	100%

**Or**

MSE 6401B:	Quizzes:	16%
(Sandhage)	First Exam:	25%
	Second Exam:	25%
MSE 6501B:	Quizzes:	9%
(Bucknall)	Third Exam:	25%
	Total:	100%

Homework: Homework exercises will be given to augment lecture notes, but will not be graded. Nonetheless, it is strongly recommended that students perform these homework exercises to better understand lecture material and for exam preparation.

Exams: Exams (1.5 hour) will be given in class at the scheduled time. Exceptions (only for very good reasons) will require making prior arrangements with the instructors.

Class Topics

MSE 6401A/  
6401B:

- I. The First, Second, and Third Laws of Thermodynamics  
(Chapter 1 of Lupis; Sears and Sallinger, Chapter 11)
- II. Thermodynamic Stability of Open Systems  
(Chapters 2, 3 of Lupis)
- III. Solution Thermodynamics  
(Chapters 4, 6, 7, 9 of Lupis)
- IV. Chemical Reaction Equilibria  
(Chapter 5 of Lupis)

MSE 6501A: V. Binary Phase Diagrams  
(Chapter 8 of Lupis)

- VI. Ternary Phase Diagrams  
(Chapter 10 of Lupis, Alloy Phase Equilibria, Prince; and Phase Diagrams for Ceramists, Vol. 1)
- VII. Interfacial Thermodynamics and Adsorption  
(Chapter 14 of Lupis)

MSE 6501B: V. Thermodynamics of Polymer Chain Conformations

- VI. Thermodynamics of Polymer Solutions and Melts
- VII. Flory-Huggins Expressions, Polymer Phase Diagrams, and Phase Transitions

## Helpful Tips for Good Performance

- 1) **Ask questions!** If you don't understand something, the odds are that you are not alone. For most of us (including me), concepts in thermodynamics are not always intuitive. Much of the understanding in thermodynamics comes about by doggedly pursuing answers to questions.
- 2) **Keep up with the lectures.** If you keep ahead of, or at least at pace with, the lectures, you can ask questions as the material is covered. This is more efficient in the long run than waiting until the last minute before a test to get questions answered.
- 3) **Do the homework in a timely fashion.** You will learn far more by taking a stab at solving problems on your own before seeing the solutions, than if you simply look at the solutions without attempting the problems first.
- 4) **Use all of the resources that you have available.** If you don't understand something covered in lecture, try reading the suggested references. Talk to other students about your questions. I am happy to help you outside of class (just stop by or call me and schedule an appointment).