MS&E 330 Fall 2016: Thermodynamics of Materials

Instructor:

Paul Evans

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Office Hours: Monday, 1-2 PM, or by appointment. Also, please feel free to drop in or email.

Teaching Assistant:

Kyle McElhinny email: mcelhinny@wisc.edu

Office Hours: Mondays 2-3 PM, location to be announced.

Course Meetings

Lecture: MWF 11-11:50 AM, Engineering Centers Building Room 1003.

Required Discussion and Activity Section: Th 1:20-2:10 PM Engineering Centers Building Room

1003

Attendance at all of these course meetings is required and will be accounted for in the Homework/Participation component of the grade. Attendance at office hours is not required.

Course Homepage

Handouts, readings, assignments, and solutions are available on the course web page at the University of Wisconsin Canvas site: https://canvas.wisc.edu/courses/437

Course emails will come from mse330-1-f16@lists.wisc.edu.

Course Description

MS&E 330 will cover the basic concepts of thermodynamics that underpin all areas of materials science and engineering. We will discuss the ideas that allow the thermodynamic state of a system to be described quantitatively and develop methods for describing materials of increasing complexity, including systems with multiple phases and multiple components.

Course Requirements

Exams

Two midterm exams: Tentatively scheduled for October 10 and November 14, in class.

Final exam: December 21, 12:25 PM- 2:25 PM. The final exam will focus material from the later part of the class.

Please let me know right away if you will not be able to be present for the midterm exams.

Homework

We will have 11 homework assignments. Follow the requirements in the "MS&E 330 Homework Guidelines and Requirements" handout.

Project

There will be a final project involving the modeling and interpretation of phase diagrams.

Grading

Homework/Participation	25%
Project	10
Midterm Exam 1	20
Midterm Exam 2	20
Final Exam	25

Resources

Course Text

D. R. Gaskell, *Thermodynamics of Materials 5th edition*, Taylor and Francis, 2008. ISBN 9781591690436, library catalog number TN673 G33 2008.

Books on Reserve (Wendt Library)

Library course homepage: https://www.library.wisc.edu/course-pages/viewer/show/13862

- 1. P. Atkins and J. de Paula, *Physical Chemistry: Thermodynamics, Structure, and Change 10th edition*, Freeman, 2014. ISBN 9781429290197.
- 2. D. V. Ragone, *Thermodynamics of materials vols. 1 and 2*, Wiley 1995. ISBN 9780471308850 and 9780471308867. Catalog number TA418.52 R34 1995.

Other resources

- 1. ASM Handbook Vol. 3 Alloy Phase Diagrams, available at: http://products.asminternational.org.ezproxy.library.wisc.edu/hbk/index.jsp
- 2. University of Wisconsin Writing Center (writing.wisc.edu) and Writer's Handbook, available at: http://writing.wisc.edu/Handbook/index.html

Lecture Schedule

eek	Date	Day	Lecture	Topic/Activity	Reading (Chapter numbers refer to the textbook by Gaskell)	Assignment
	9/7	w	1	Introduction, Basic Concepts: System, components, phases, phase diagrams	Chapter 1 and Math Review Handout	
			Discussion/Activity		Chapter 1 and Math	
-	9/8	Th	Section	Math review, homework 1 activities Basic Concepts: State, equation of state, properties, extensive, intensive parameters. Background Math:	Review Handout Chapter 1 and Math	
	9/9	F	2	logarithms, differentials, exact differentials, partial derivatives, relationships among partials	Review Handout	
	9/12			First Law of Thermodynamics: Work and heat: mechanical equilibrium, simple equilibrium, heat and	Charata 2	
	9/12	IVI	3	Constant volume and Constant Pressure Processes, Enthalpy H: Constant volume and constant pressure	Chapter 2	
	9/14	W	4	heat capacity	Chapter 2	Homework 1 Due
	9/15	Th	Discussion/Activity Section	Homework 2 activities	Chapter 2	
	9/16		5	Reversible Processes: Reversible adiabatic and isothermal processes, heat conduction	Handouts	
	- 1			Thermochemistry, Phase Transformations, and Reactions Calorimetry: Cooling curves, differential		
	9/19 9/21		7	scanning calorimetry, heats of reaction, specific heat Chemical Reactions: Chemical equilibria, rate of reactions, Arrhenius relation	Handouts Chapter 3	Homework 2 Due
	-,		Discussion/Activity			
_	9/22	Th	Section	Homework 3 activities	Chapter 3	
	9/23	F	8	Second Law of Thermodynamics Reversible and Irreversible Processes: Heat engines and Entropy, thermodynamic temperature scale	Chapter 3	
	9/26		9	Entropy and the Requirement for Equilibrium: Energy maximized for fixed U, V	Chapter 4	
	9/28	\	10	Statistical Interpretation of Entropy: Entropy and disorder: microstates, configurational entropy, thermal	Chantas 4	Hamawark 2 Dua
	9/20	VV	Discussion/Activity	entropy	Chapter 4	Homework 3 Due
	9/29		Section	Homework 4 activities	Chapter 4	
-	9/30		11 12	Example: Statistical mechanics of polymers Statistical Interpretation of Temperature: Equilibrium between system and heat reservoir	Handouts Chapter 5	
	10/3		13	Auxiliary Functions: Enthalpy, H, Helmholtz Free Energy, A, and Gibbs Free Energy, G	Chapter 5	Homework 4 Due
			Discussion/Activity			
-	10/6		Section 14	Review for Exam 1 Chemical potential	Chapter 5	
	10/10	_	15	unemed potential	enapter 5	Exam 1 in Class
	10/12	W	16	Maxwell's equations and relations among the auxiliary parameters	Chapter 5	
	10/13	Th	Discussion/Activity Section	Homework 5 activities	Chapter 5	
	10/14		17	Heat Capacity and 3rd Law of Thermodynamics	Chapter 6	
	10/17		18	Theoretical Calculation of Heat Capacity: Crystal Vibrations, Phonons, Einstein and Debye models	Chapter 6	
	10/19	W	19	Enthalpy as function of temperature and composition: Thermochemical data, Richard's Rule	Chapter 6	Homework 5 Due
	10/20	Th	Discussion/Activity Section	Homework 6 activities	Chapter 6	
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	10/21	F	20	Phase Equilibria in a One-Component System: Gibbs Free Energies of the phases; Clapeyron and Clausius	Chanter 7	
	10/21		20 21	Clapeyron Equations	Chapter 7	
	10/21 10/24 10/26	М	21 22		Chapter 7 Chapter 7 Chapter 7	Homework 6 Due
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