MSE 504
Thermodynamics of Materials
Fall 2021

COURSE OUTLINE

Classroom: 231 Scott
Dr. Qiang (David) WANG
Office: 350 Scott

Textbook: None.

Reference Books: (R1) DeHoff, *Thermodynamics in Materials Science*, 2^{nd} Ed.;
Gaskell et al., Introduction to the Thermodynamics of Materials, 6^{th} Ed.;
Tester & Modell, *Thermodynamics and its Applications*;
Callen, *Thermodynamics and an Introduction to Thermostatistics*.

Organization: The course consists of 2 lecture periods per week, M 4:00-5:15pm & W 3:00-4:15pm.

Homework: There will be homework assignments. Students are encouraged to work in groups, but copying is not allowed. Assignments are due at the beginning of class. Each assignment must be submitted by its due time. ***Homework done using solutions from any source will receive 0 credit.*** **Homework results represent 50% of the grade for the course**.

Project: There will be one project on "Selected Topics in Thermodynamics". Each student will be required to give a mini-lecture on a selected topic and to answer any questions from the audience (including rest of the class and instructor). The project will be graded by the audience. **The project results represent 10% of the grade for the course**.

Examinations: There will be one mid-term exam and one final exam for this course, both of which are closed book, but 1-page (letter-size, single-sided) notes and a calculator can be used. There will be no makeup exam and students will receive 0 credit for any exam they fail to take unless the absence is excused. Requests for an excused absence from an exam must be submitted in writing to the instructor by the end of the day following the exam. Both exams will be cumulative. **Results of the mid-term and final exams will each represent 20% of the grade for this course**.

Office Hours: M 5:20-6:20pm in 350 Scott given by the instructor. You can also set up an appointment outside this time with the instructor (970-491-2763 or q.wang@colostate.edu).

Catalogue Description: The determination of whether and the means by which a given reaction can occur. Macroscopic and microscopic solid-state thermodynamics with experimental methodologies for characterizing them, with a focus on thermodynamic and statistical mechanical aspects of material structure-property relationships.

Prerequisites: Thermodynamics and Calculus at the undergraduate level are needed for taking this course.

Additional Information

Important information for students: All students are expected and required to report any COVID-19 symptoms to the university immediately, as well as exposures or positive tests from a non-CSU testing location.

If you suspect you have symptoms, or if you know you have been exposed to a positive person or have tested positive for COVID, you are required to fill out the COVID Reporter (https://covid.colostate.edu/reporter/). If you know or believe you have been exposed, including living with someone known to be COVID positive, or are symptomatic, it is important for the health of yourself and others that you complete the online COVID Reporter. Do not ask your instructor to report for you. If you do not have internet access to fill out the online COVID-19 Reporter, please call (970) 491-4600. You may also report concerns in your academic or living spaces regarding COVID exposures through the COVID Reporter. You will not be penalized in any way for reporting. When you complete the COVID Reporter for any reason, the CSU Public Health office is notified. Once notified, that office will contact you and, depending upon each situation, will conduct contact tracing, initiate any necessary public health requirements and notify you if you need to take any steps.

For the latest information about the University's COVID resources and information, please visit the **CSU COVID-19 site**: https://covid.colostate.edu/.

Academic Integrity Policy

This course will adhere to the Academic Integrity Policy of the Colorado State University General Catalog and the Student Conduct Code. The policy is zero tolerance. The ***minimum*** action taken for academic dishonesty will be a failing grade for the course. In particular:

- Students may not copy any part of a homework assignment or an exam from other students, ***including those in previous years***. The student who knowingly provides his/her assignment or exam to be copied is also in violation of the CSU policy. Students, however, are allowed and encouraged to work in groups on homework assignments.
- Students are forbidden to use solution manuals from any source. The resources that the students are allowed to use for homework are limited to the reference or similar books, lecture notes and handouts, and data handbooks. For the project, other resources may be used.
- Discussing the content of an exam with someone who has not taken the exam is not allowed.

Mini-Lecture on "Selected Topics in Thermodynamics"

Examples of the topic are: "*History of Thermodynamics*", "*What Is Entropy?*", "*Clean the Mess of Mixtures*", "*Phase Diagrams of …*", etc. Each student should discuss with the instructor about his/her selected topic and scope before preparing for the mini-lecture. The lecture should be well organized (no longer than 15 minutes, including the time for questions). Whiteboard and computer projector are available for the presentation. All mini-lectures will be graded by the audience on a scale of 1~10 (1 for the worst and 10 for the best lecture you've ever had).

COURSE OUTLINE

Learning objectives (can also be used as your study guide for exams)

The student successfully completing this course will be able to:

1. Derive the relations among various thermodynamic quantities (transform derivatives);
2. Explain the differences between the thermodynamic potentials and describe the conditions under which those potentials are minimized in equilibrium;
3. Identify the physical (or microscopic) origins of entropy;
4. Apply the equilibrium criteria to single- and multicomponent systems;
5. Utilize temperature and pressure dependence of Gibbs free energy to construct unary phase diagrams;
6. Explain the meaning of partial molar properties, mixing functions, fugacity, and activity;
7. Use the composition-dependent Gibbs free energy to construct phase diagrams for binary mixtures;
8. Rationalize the existence of miscibility gaps and utilize the common tangent construction to establish the miscibility gap range;
9. Calculate the change of enthalpy, entropy and Gibbs free energy for reactions as a function of temperature and pressure, and solve basic chemical reaction equilibrium problems.

COURSE OUTLINE

Preliminary Class Schedule (8/20/21)

Week	Date	Topic	R1
1	Aug. 23 Aug. 25	Why Study Thermodynamics? The Structure of Thermodynamics	Chap. 1 Chap. 2
2	Aug. 30 Sep. 1	The Laws of Thermodynamics Thermodynamic Variables and Relations	Chap. 3 Chap. 4
3	Sep. 6 Sep. 8	***No Class (Labor Day)***	
4	Sep. 13 Sep. 15	 Equilibrium in Thermodynamic Systems	 Chap. 5
5	Sep. 20 Sep. 22	 Statistical Thermodynamics	 Chap. 6
6	Sep. 27 Sep. 29	 Unary Heterogeneous Systems	 Chap. 7
7	Oct. 4 Oct. 6	 ***Mid-term Exam*** (3:00~5:00pm)	
8	Oct. 11 Oct. 13	Multicomponent Homogeneous Nonreacting Systems: Solutions	Chap. 8
9	Oct. 18 Oct. 20		
10	Oct. 25 Oct. 27	Multicomponent Heterogeneous Systems	Chap. 9
11	Nov. 1 Nov. 3	Thermodynamics of Phase Diagrams	Chap. 10
12	Nov. 8 Nov. 10	 Multicomponent Multiphase Reacting Systems	 Chap. 11
13	Nov. 15 Nov. 17		
14	Nov. 22 Nov. 24	***No Classes and Office Hours This Week – Fall Recess***	
15	Nov. 29 Dec. 1		
16	Dec. 6 Dec. 8	***Mini-Lectures***	
	Dec. 13	***Final Exam*** (4:10-6:10pm)	

Note: *This schedule, including the date of mid-term exam, may be modified during the semester.*