CHEMICAL ENGINEERING 141 Syllabus

Thermodynamics, Spring 2017

Instructor: Prof. Markita Landry, 106 Gilman Hall, 664-7627, landry@berkeley.edu

Graduate Student Instructors: Andrew Crothers, arcrothe@berkeley.edu
Peter Dudenas, pete.dudenas@berkeley.edu
Julie Rorrer, jrorrer@berkeley.edu

Lectures: 120 Latimer, T&Th 9 :30 – 11:00 am

Discussions: (1) 70 Evans, Mon 9:00 – 10:00 am GSI- Andrew Crothers
(2) 255 Dwinelle, Tues 8:00 – 9:00 am GSI- Julie Rorrer
(3) 179 Dwinelle, Wed 8:00 – 9:00 am GSI - Andrew Crothers
(4) 102 Latimer, Wed 9:00 – 10:00 am GSI- Julie Rorrer
(5) 254 Dwinelle, Thurs 8:00 – 9:00 am GSI - Pete Dudenas
(6) 102 Latimer, Fri 9:00 – 10:00 am GSI - Pete Dudenas

Online discussion:
This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the GSI, and the instructor. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza.
Signup Link: piazza.com/berkeley/spring2017/cbe141

Office hours: Prof. Markita Landry: M 2-3 in 106 Gilman
GSIs:
T 4-5pm, 5-6pm by appointment only, in Library Seminar Room 100D (Julie Rorrer)
W 5-6pm by appointment only in Bixby North (Peter Dudenas)
W 7pm-8pm, 6-7pm by appointment only in Bixby North 100F (Andrew Crothers)
Th 6pm-7pm Library Seminar Room 100F (Peter Dudenas)

Required Textbook:

Introduction to Chemical Engineering Thermodynamics – UC Berkeley CHMENG141 Edition (2005) by J.M. Smith, H.C. Van Ness, and M.M. Abbott.
Reading assignment will be posted for every lecture on bcourses.
Lecture outline notes will be posted for every lecture on bcourses. You are encouraged to download or print note outlines to follow along in class.

Reference Texts

Introduction to Chemical Engineering Computing (2012) by Bruce Finlayson
The Properties of Gases and Liquids (2000) by B.E.Poling, J.M. Prausnitz, J.P. O'Connell
Chemical and Engineering Thermodynamics (1989) by S.I. Sandler.
Chemical and Process Thermodynamics (1992) by B.G. Kyle

Syllabus: Chm Eng 141 – Thermodynamics (cont.)

Prerequisite:

CBE 140, Introduction to Chemical Engineering, with a grade of C- or higher, and Engineering 7 (concurrent enrollment permitted).

Course Objectives:

By the end of this course, students will have learned:

- the terminology of thermodynamics: system, properties, processes, reversibility, equilibrium, phases, components.
- the relationship between heat and work by understanding the significance of the first law of thermodynamics.
- the limitations imposed by the second law of thermodynamics on the conversion of heat to work.
- the definitions and relationships among the thermodynamic properties of pure materials, such as internal energy, enthalpy, and entropy.
- how to obtain or to estimate the thermal and volumetric properties of real fluids.
- the applications of energy balances in the analysis of batch, flow, and cyclical processes, including power cycles, refrigeration, and chemical reactors.
- thermodynamics of fluid mixtures and its application to separation processes such as distillation and extraction.
- chemical-reaction thermodynamics and its application to homogenous and heterogeneous chemical reactions with multiple components.

Course Outcomes:

At the end of this course, students will:

- understand and analyze processes such as isothermal, isobaric, isentropic, cyclic;
- analyze steam power cycles; refrigeration cycles, and liquefaction;
- use equations of state, correlations and tables for nonideal fluids;
- apply equilibrium criteria to systems
- relate thermodynamic properties via partial derivatives, Maxwell's relations;
- be able to interpret phase diagrams of binary systems;
- be able to calculate vapor-liquid equilibria for non-electrolyte systems;
- solve for equilibrium compositions in homogeneous and heterogeneous chemical reactions.

Grading:

5% Homework
10% Quizzes
25% Midterm Exam 1
25% Midterm Exam 2
35% Final Exam

Quizzes will be given occasionally in your assigned discussion section to assess your comprehension of the material covered by homework, lectures, discussions, and the reading. Quizzes cannot be made up. The lowest quiz score will be dropped. Your homework will be due to your GSI on Friday of the week's assignment, and will be graded for completion.

Syllabus: Chm Eng 141 – Thermodynamics (cont.)

Exams will be challenging and you will need to study extensively to perform well. All exams will be written and consist of problem sets, short answer, multiple choice, and/or true/false questions. Midterm exams will be held according to the schedule below. All cell phones must be stored away during exams. Use of a cell phone or texting during an exam will lead to an automatic F. One equation sheet will be permitted at the discretion of the instructor; this may be provided or prepared by the student depending on the instructions prior to the exam. **Exams cannot be made up** – For all students, we will drop your lowest *midterm* exam grade. You cannot miss the final. If you are absent for an exam, you will receive a grade of zero, and this will become the exam that is dropped from your course grade. Students that must miss more than one exam should consider dropping the course. The midterms will be held as follows:

Midterm Exam 1 is scheduled for February 14th, and Midterm Exam 2 is scheduled for March 23rd. Both will be held during lecture.

The Final Exam is scheduled for Wednesday May 10th, from 11:30 am – 2:30 pm.

There will be no exam regrades. If you notice an error in totaling the points (this is NOT a regrade), attach the note to your exam and discuss the issue with the GSI. This procedure must be followed within one week of the time the exams are initially returned to the class; after that period the exam will not be retotaled. In addition, the GSI will review the entire exam when retotaling the score. If there is a disagreement with the GSI you can visit with the Instructor during office hours.

Extra credit may be offered at the discretion of the instructor.

Topics Covered

1. Concepts and definitions
2. First and second laws of thermodynamics
3. Fundamental equations of thermodynamics
4. Applications of the first and second laws to closed and open (steady and unsteady state) systems
5. Maxwell relations and other relations among properties
6. Volumetric properties and equations of state of pure fluids
7. Correlations of the thermal and volumetric properties of real fluids
8. Phase equilibrium in single-component systems
9. Power cycles; refrigeration cycles, and liquefaction of gases
10. Thermodynamics of fluid mixtures
11. Ideal and non-ideal mixtures
12. Chemical potential; fugacity and its calculation
13. Binary phase equilibria: vapor-liquid, liquid-liquid, vapor-liquid-liquid, and solid-liquid
14. Thermodynamics of chemical reactions
15. Third law of thermodynamics and its significance