Chemical and Biomolecular Engineering Thermodynamics I
CHBE 301

Lecture: Tuesday & Thursday, 2:00-3:15 pm (CHE 2110)
Recitation Section: Wed, 11:00-11:50 pm (CHE 2108)
Fall 2017

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Course Description

This course will focus on the theory and application of thermodynamics of mainly single-component gasses, fluids and solids. A review from past courses on the general mass balance equation will be essential in developing fundamentals for the main focus of this course on energy and entropy balances. The concept of energy conservation will be introduced and how this applies to changes in thermodynamic properties of a system. Meanings of thermodynamic state properties (volume, density, enthalpy and heat capacity) will be demonstrated at the molecular- and bulk-scales. The concept of entropy will be introduced and how this applies to the concept of a reversible process. The developed mass, energy and entropy balances will be used to solve engineering problems of simple unit operations to those involved in power generation and refrigeration. This course will end with a focus on thermodynamic properties of real substances and associated equations of state to predict these properties. This course provides the fundamentals for the following semester on phase equilibrium and thermodynamics of mixtures. Class time will be devoted to a variety of activities, including lecture and individual or small group problem solving.

Course Objectives for Students

- Understand the use of balance equations for mass, energy and entropy.
- Apply the thermodynamic balance equations to various chemical processes.
- Relate thermodynamic properties and predict these with equations of state.
- Improve communication skills by classroom discussion, problem solving, and written assignments.

Required Course Readings

Textbook

- Stanley I. Sandler. (2017). *Chemical, Biochemical, and Engineering Thermodynamics.* (5th Ed.). USA: John Wiley & Sons, Inc. ISBN: 978-0-470-50479-6

Useful Websites

- webbook.nist.gov/chemistry/
- http://bcs.wiley.com/he-bcs/Books?action=index&bcsId=10818&itemId=111932128X

Computer Software

Some homework problems may require the use of software, such as Excel, Matlab, or Mathcad.

Lecture

The lecture time will consist of an overview of the topics given in the course calendar for that day. Students are expected to read the material to be covered that day before class. Many lecture periods will also consist of in-class problem solving in groups based on the lecture material. Therefore, **always bring your textbook and a calculator to class**.

Recitation Section

A quiz of select problems will be posted on ELMS and graded the day before recitation. The actual recitation section will be used to go over assigned problems which the students had the most difficulty. Interactively as groups students will go through additional problems with the graduate TA to supplement the regular lecture. Solutions will not be posted on ELMS and students are expected to attend.

Class Participation

Students will be expected to participate in class and during group problem solving activities. Solutions to these problems will be discussed and presented by students. Everyone is expected throughout the semester to contribute to these discussions.

Homework

Homework problems will be assigned regularly and will be graded. These will consist of problems that only require pencil and paper to those that require software. These will be done in groups of two students. You are allowed to help each other on the homework problems but **each group must turn in their own work**. Homework that is copied from another student/group is in violation the university's Code of Academic Integrity. Similarly, you are not allowed to use solutions from previous students.

Exams

There will be two midterm exams (**October 3 and November 7)** and a final exam (**December 16**) and are considered *Major Grading Events*. The midterm exams will only cover the material listed on the course calendar. The final is comprehensive but about half of the exam will be on problems related to the final third of the course. All exams are *CLOSED* book, but one "cheat-sheet" (front/back) and calculator are allowed for the midterms and three cheat-sheets for the final.

Grading Summary

Homework	15%
Exam 1	20%
Exam 2	20%
Final Exam	35%
Recitation Quiz	10%

Class Policies

Absences from class: If you must miss class for any reason, I strongly recommend that you ask a classmate for any notes, handouts, or announcements you may have missed. In addition, please notify me as far in advance as possible if you know that you are going to miss class for a university-approved reason, so that we can discuss any necessary arrangements. Please see the Undergraduate Catalog's description of university-approved reasons for absence (http://www.umd.edu/catalog) and our Department's policy http://www.chbe.umd.edu/policies/index.html.

Academic integrity: The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the definitions and consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.shc.umd.edu and our Department's policy http://www.chbe.umd.edu/policies/index.html. Violations of the code will not be tolerated in this class.

Accommodations for students with disabilities: In order to receive accommodations, students with learning disabilities must provide a written request and documents from the University of Maryland Disability Support Services (http://counseling.umd.edu/DSS). Please submit any requests by **September 8**.

Cell phones: Please keep cell phones and other communicative devices silent and out of sight during class. Text messaging is not allowed during class.

Inclement weather: In the event of inclement weather, I will comply with the University's decision regarding whether classes are going to be held or not. Any assignments due on the day of a cancellation will be due instead at the next class meeting.

Late Homework: These items are due at the designated time stated on each assignment. Email submissions will not be accepted, unless approved by myself. The penalty for lateness without a university-approved reason for absence on the due date is half credit up to 24 hours late and no credit after 24 hours.

Make-ups: Exams and quizzes may only be made up if you are absent for a documented, university-approved reason. If you miss class without a university-approved reason on a day that an exam or quiz takes place, you will not be able to make it up.

Religious observation: If you will miss class on the day of an exam or on the date that an assignment is due because of a religious observation that is not officially recognized by the university, you must contact me **at least 2 weeks before your anticipated absence** in order to discuss alternative dates for the exam or assignment.

ELMS/CANVAS (www.elms.umd.edu): On ELMS, I will post this syllabus, assignments, and any major changes to the course calendar. In addition, I may sometimes post handouts utilized in class and links to useful web sites. Lecture notes will be posted in the Pages section. You will also be able to access your grades via ELMS.

CourseEvalUM (www.courseevalum.umd.edu): Your participation in the evaluation of courses through CourseEvalUM is a responsibility you hold as a student member of our academic community. Your feedback is confidential and important to the improvement of teaching and learning at the University as well as to the tenure and promotion process. By completing all of your evaluations each semester, you will have the privilege of accessing online, at Testudo, the evaluation reports for the thousands of courses for which 70% or more students submitted their evaluations.

Course Calendar

Note: Students should read the chapter associated with the lecture PRIOR to class. Homework (HW) assignment dates are tentatively listed; due dates will be listed on the assignment.

Day	Date	Topic	Chapter/Section	HW
Tue	Aug 29	Overview of Syllabus Introduction to Thermodynamics Mass Conservation (Integral Form)	Ch. 1 and Ch. 2.1 to 2.2	
Thr	Aug 31	Mass Conservation (Integral and Rate-of-Change)	Ch. 2.2 and 2.3	#1
Tue	Sep 5	Conservation of Energy	Ch. 3.1	
Thr	Sep 7	Simple Examples of the Energy Balance	Ch. 3.2	#2
Tue	Sep 12	Thermodynamic Properties of Matter (macro & molecular) and Applications	Ch. 3.3, 3.4 & Notes	
Thr	Sep 14	Applications of Mass and Energy Balances	Ch. 3.4	#3
Tue	Sep 19	Applications of Mass and Energy Balances	Ch. 3.4	
Thr	Sep 21	Case Study of Combined Unit Operations	Notes	#4
Tue	Sep 26	Introduction to Entropy and its Balance Equation	Ch. 4.1 and 4.2	
Thr	Sep 28	Entropy for heat, work and engines Exam Review	Ch. 4.3	
Tue	Oct 3	**EXAM 1**	Covered Material in Chapters 1-3	
Thr	Oct 5	Entropy for Changes in Matter and Applications	Ch. 4.4 and 4.5	#5
Tue	Oct 10	Entropy Balance Applications	Ch. 4.5	
Thr	Oct 12	Entropy Balance Applications	Ch. 4.5	#6
Tue	Oct 17	Case Study of Combined Unit Operations	Notes	
Thr	Oct 19	Liquefaction	Ch. 5.1	
Tue	Oct 24	Power Generation & Refrigeration	Ch. 5.2	
Thr	Oct 26	Power Generation & Refrigeration	Ch. 5.2	#7
Tue	Oct 31	Thermodynamic Efficiencies and Explosions	Ch. 5.3 and 5.4	
Thr	Nov 2	Thermodynamic Efficiencies and Explosions	Ch. 5.3 and 5.4	#8
Tue	Nov 7	**EXAM 2**	Covered Material in Chapters 4-5.2	
Thr	Nov 9	Calculus for Thermo and Partial Derivatives	Ch. 6.1 and 6.2	
Tue	Nov 14	Introduction to Non-ideal gas at the molecular level and Virial Equation	Notes	
Thr	Nov 16	Basic Forms of Equations of State and Thermo Properties of Real Substances	Ch. 6.4	#9
Tue	Nov 21	*No Class (Extended Break)*		
Thr	Nov 23	*Thanksgiving Break (no class)*		
Tue	Nov 28	Thermo Properties of Real Substances and Change of State of a Real Gas	Ch. 6.4 and 6.5	
Thr	Nov 30	Corresponding States	Ch. 6.6	#10
Tue	Dec 5	Generalized Equation of State, Third Law and Estimation of Critical Properties	Ch. 6.7-6.9	
Thr	Dec 7	Further Examples of Energy/Entropy balances with Equations of State		#11
Sat	Dec 16	**FINAL EXAM, 10:30am-12:30pm**	All course material	