SYLLABUS: CHEMICAL ENGINEERING THERMODYNAMICS

Course ethics: Ethical conduct in courses and in the practice of engineering is very important. All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including—but not limited to—university probation, suspension, or expulsion). Additional information regarding the Honor Code can be found online (http://honorcode.colorado.edu/) and at the Honor Code Office.

Some examples (this list is not complete) of violations of course ethics and the honor code are:

i. Using someone else's clicker in class or giving your clicker to someone else.
ii. Using a solutions manual or equivalent (e.g., solutions posted on the web or from previous course offerings) in the preparation or submission of homework.
iii. Copying the solution of another team or another person.
iv. Presenting someone else's work as your own, which includes submitting a team assignment in which you did not do all the problems.
v. Obtaining answers to online quizzes from someone or giving someone answers to online quizzes.
vi. Any time you present someone else's work or answer as your own.

Every student in a team is responsible (and will be considered to have violated the Honor Code) if a team member violates the Honor Code. For example, if a team decides to divide up problems (which should not be done) and someone copies a solution from someone else, the entire team will be reported to the Honor Code Board; the entire team could fail the course. Team solutions for assignments should be the result of collaboration: each member should work on each problem, and all members should discuss and teach one another. Each assignment is required to have the signature of each team member. The signature means **"This assignment was done jointly and each of us knows how to do each problem. On my honor, I have neither given nor received unauthorized assistance on this work"**

In-class ethics: Your behavior in class should not disrupt the class or affect the ability of other students to learn. You will be required to sign a contract that commits you to the following:

i. Putting your computer away unless you have permission from Professor Fox to use it in class.
ii. Turning off your cell phone ringer and putting your phone away
iii. Taking off your smart watch and putting it away.
iv. Not talking while the instructor or other students are talking.

Importance of Course:

An understanding of thermodynamics is needed to become a chemical, biological, or environmental engineer. Thermodynamics can determine the feasibility of a process, and it is one of the most important courses in the curriculum. The concepts are used in subsequent courses (e.g., kinetics, separations and mass transfer, design, and materials), and they are applicable to many areas of engineering. The increased emphasis on energy utilization and transformation due to increased demand, diminishing supply, and global warming requires the engineers who will solve these problems to have a clear understanding of thermodynamics.
In this course, the first law and second laws will be reviewed. Emphasis will be on nonideal properties of single component and multicomponent systems. A major part of the course is devoted to phase equilibrium, which is important for separations (e.g., distillation, extraction, and membranes) and chemical equilibrium.

Objectives:

***With your help*, make this the class where you learn the most**

i. Increase your understanding of—and ability to apply—thermodynamics.
ii. Develop a conceptual understanding of relevant equations and processes.
iii. Prepare you for subsequent courses and the F.E. exam.
iv. Prepare you to tackle the unusual problems that arise so often in engineering.
v. Improve your problem solving ability.
vi. Improve your ability to work in teams.

Expectations:

i. Attend all classes and be on time.
ii. Cell phone is powered off during class; computers not used in class without prior approval.
iii. Participate in class. Extra credit will be given for participation.
iv. Complete reading, view screencasts, and answer reading quizzes prior to class.
v. The major responsibility for learning must be by reading the book, watching the screencasts, and doing the homework. We will not spend much time in class repeating material covered by the text. Instead, we will use class time to discuss the more-difficult concepts, as well as applications and examples.

Resources to help you succeed in this course:

Extensive resources on LearnChemE.com, including:

i. Over 350 thermodynamics screencasts
ii. 43 interactive thermodynamics screencasts
iii. Over 55 interactive thermodynamics simulations with accompanying screencasts

Resources on D2L:

i. Last year's exams
ii. Chapter objectives for each chapter
iii. Screencasts on how to study and how to use screencasts on D2L
iv. Links to interactive simulations organized by textbook chapter

Jerome's scheduled office hours: 4:30 PM on Monday (after class), open door policy
Other: W and Th afternoon help session (4:30 – 5:30 in A108) Jerome will be there on W (at least).

Format: This class will consist of Concept Tests (using an iClicker), group problems, and in-class participation (questions and discussion).

Prerequisites: Grades of "C-" or better must be obtained in Physical Chemistry for Engineers and CHEN2120.

Instructor: Jerome M. Fox

Discussions: Inquiries concerning the course or assignments should be posted in Discussion forums under the appropriate topic in D2L.

Text: *Introductory Chemical Engineering Thermodynamics*, 2nd edition. J.R. Elliott and C.T. Lira, Only some sections will be covered in some chapters (see chapter objectives, course schedule).

D2L: Class notes will be posted after class; in many cases, they will also contain more detailed explanations of the clicker questions. Course handouts, files, announcements, assignments, reading assignments, reading quizzes, screencasts, and links to interactive simulations will be posted.

Grading:

Homework assignments	15%
2 (evening) exams	35%*
Concept quizzes	10%
Reading quizzes	10%
Final exam	30%
Participation	2% extra credit

* The mid-term exam on which the student receives the higher grade will count 20%, the other will count 15%.
If your average for the three exams is lower than 52, then homework assignments will not count in determining your course grade. Instead, the percentages for the other items will be increased.
The grading scale for the final course grades is as follows:

88 < A
78 < B < 88
62 < C < 78
52 < D < 62
F < 52

You are guaranteed the indicated letter grade (with a minus) if you have the minimum numerical grade (e.g., if your course average is 78, you are guaranteed at least a grade of B- in the course). Grades may be adjusted, but only in your favor.

Exams: The equations list for each exam (posted on D2L under Exam Review modules) should be printed out and brought to the exams. For exam 2, you may bring the equations for both exam 1 and 2. For the final exam, you may bring the equations for exams 1 and 2 and for the final exam. You must have your name on each page of the equations, and you may make notes on the front of the pages. Additional pages may also be posted on D2L (steam table, physical properties, etc.) that you can also bring to the exams. Please use a pencil that writes dark. Note that exams are from 6:30 to 8:30 PM on **Thursday, September 29 and Thursday, November 3.** The final exam is **Wednesday, December 14 from 4:30 to 7:00 PM**.
NO MAKE-UP EXAMS WILL BE GIVEN.

In class: Conceptual problems will be given in every class. To allow for a few missed classes, the five days with the lowest percentage grade will be dropped when computing the concept tests grade. The class average on the concept tests has historically been A-.

Class participation: A total of 2 bonus points (the 2% participation points in the grading scale) will be added to the final numerical average for each student who satisfies the following criteria:
1. The student must offer an individual question, comment, or response during classroom discussion that is ***related to the technical material covered in the course*** (i.e., administrative questions such as "When is the next exam?" don't count) six times during the semester.
2. Each student must keep track of the specific dates on which (s)he completed the above requirements. (S)he must then *submit a signed form* (available on D2L) at the start of the last class period.

Reading quizzes: A total of 10% of your course grade will be determined by responses to short reading quizzes related to the assigned reading and/or screencast viewing. **Reading quizzes must be completed independently on D2L before 9 am** the day of each class. I will use the reading quiz responses before class to help identify the most important topics to cover during the class period.

Assignments: Most assignments will be done in teams of 3 people. Assignments will be submitted as PDF files to dropbox folders in D2L. **Late assignments will not be accepted**. Present your solutions clearly. Do not squeeze the problems together. Leave margins. Write large enough so that the solutions can easily be read. You must follow the homework format on D2L, which requires boxes for a solution plan, a diagram, and a final answer. When you scan your homework, make sure that it can be easily read.
Teams will be assigned via computer program; if you are registered for the course, you will receive an e-mail telling you how to sign up for a homework team. This cooperative (team) learning is important training for industry, and several studies have shown that it results in enhanced learning. As reported in an *ASEE Magazine*, "Many of today's most successful engineering graduates have more of a team orientation, which is

essential". The key to a team's success is that they should meet **after** each member has worked on the problem set.

Teams will be asked to submit individual effort assessments. These assessments will be used to adjust the HW grades.

Team policies and expectations: Your team will have the following responsibilities:

i. *Agree on a common meeting time and what each member should have done before the meeting by way of preparation*.
ii. *Do the required individual preparation*. Each team member should attempt to outline the solution of each problem before the team meets.
iii. *Meet and work out the complete solutions to all assigned problems.* Agree on next meeting time and roles for next assignment.
iv. *Review graded assignments*. Make sure everyone understands why points were lost and how to correct errors.
v. *Complete and submit peer rating sheets for all team members when required*. Ratings will be collected near midterm and near the end of the semester. They will be confidential.

Omitting names from assignments, firing, and quitting

i. If a team member refuses to cooperate on an assignment, his/her name should not be included on the completed work. If a team member is uncooperative, the cooperating team members may notify the uncooperative member by email (copy to Fox) that he/she is in danger of being fired, and the team should meet with the course instructor and attempt to resolve the problem. If no resolution is achieved within a week, the team should send an email to the person that he/she is no longer part of the team (copy Fox).
ii. A student who is consistently doing most of the work on a team may issue a warning email (copy to Fox) that he/she will quit unless more cooperation is forthcoming. If the noncooperation continues, the student doing the work may notify the others by email (copy to Fox) that he/she is no longer part of the team.
iii. *Students who are fired or who quit must find a team of 3 unanimously willing to accept them as a member, otherwise they will receive zeroes for the remaining assignments.*
iv. Team work isn't always easy: team members sometimes cannot prepare for or attend team sessions because of other responsibilities, and conflicts often result from differing skill levels and work ethics. When teams work and communicate well, however, the benefits more than compensate for the difficulties. One way to improve the chances that a team will work well is to agree beforehand on what everyone on the team expects from everyone else.

Classroom Behavior: Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies at http://www.colorado.edu/policies/classbehavior.html and at http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

Disability: If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at

dsinfo@colorado.edu. If you have a temporary medical condition or injury, see Temporary Injuries guidelines under the Quick Links at the Disability Services website and discuss your needs with your professor.

Discrimination and Harassment: The University of Colorado Boulder (CU-Boulder) is committed to maintaining a positive learning, working, and living environment. CU-Boulder will not tolerate acts of discrimination or harassment based upon Protected Classes or related retaliation against or by any employee or student. For purposes of this CU-Boulder policy, "Protected Classes" refers to race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Individuals who believe they have been discriminated against should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or the Office of Student Conduct and Conflict Resolution (OSC) at 303-492-5550. Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding discrimination or harassment can be found at the OIEC website. The full policy on discrimination and harassment contains additional information.

Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments, or required attendance. In this class, please contact me if you have a conflict with one of the exams so we can make appropriate arrangements. See full details at http://www.colorado.edu/policies/fac_relig.html
If you have too many final exams on one day, the university allows for accommodations if you notify the instructor of the last exam of the day before 6 weeks of the semester are over.

CHEN 3320: ChE Thermodynamics Department of Chemical and Biological Engineering
Fall 2016

Tentative Course Schedule

WEEK	DATE	TOPIC	Chapters, Sections
1	Aug 22 - 26	Introduction, Course Organization, First Law	1,2
2	Aug 29 - Sept 2	Introduction, Energy Balance	2
3	*Sept 5*	*Labor day holiday*	-----
3	Sept 7 - 9	Energy Balances	3, 4
4	Sept 12 - 16	Entropy.	4
5	Sept 19 - 23	Processes, Generalization to any fluid	4
6	Sept 26 – Sept 30	Equations of state	5, 6
6	Thursday, Sept 29	EXAM #1, 6:30- 8:30 p.m., A108, A104	1 – 5
7	Oct 3 - 7	Equations of state, Departure functions	7, 8, 9
8	Oct 10 – 14	Phase Equilibrium, pure flow, multicomponent	9, 10
9	Oct 17 – 21	Phase equilibrium, multicomponent	10
10	Oct 24 – 28	Multicomponent systems, activity models	11, 14
11	Oct 31 - Nov 4	Phase Equilibrium, partially miscible	14
11	Thursday, Nov 3	EXAM #2, 6.30 - 8:30 P.M. , A108, A104	6 - 11
12	November 7 - 11	EOS approach to phase equilibrium, Chemical equilibrium	14, 15, 17
13	November 14 - 18	Reacting Systems	17
14	*Nov 21 - 25*	*Fall Break &Thanksgiving holiday*	--------
15	Nov 28 – Dec 2	Reacting Systems	17
16	Dec 5 - 9	Review	
Exam	Monday, Dec 12	FINAL EXAM 4:30 - 7:00, A108, A104?	All