
SYLLABUS: CHEMICAL ENGINEERING THERMODYNAMICS

Honor Code:

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

Examples of violations of the honor code include, but are not limited to, the following actions:

- Answering someone else's in-lecture quizzes or letting someone else answer your in-lecture quizzes (recorded lectures)
- Using someone else's clicker in class or giving your clicker to someone else (live lectures, if we have the opportunity)
- Using a solutions manual or equivalent (e.g., solutions posted on the internet or from previous course offerings) in the preparation or submission of homework
- Copying the solution of another person or team
- Presenting someone else's work as your own
- Submitting a team assignment in which you did not do all of the problems
- Obtaining answers to online quizzes from someone or giving someone answers to online quizzes (i.e., any time you present someone else's work as your own)

If one member of a team violates the honor code, every member of that student's team will be held responsible and will be considered to have violated the honor code. That is, if a team decides to divide up problems (which should not be done) and one member of the team copies a solution (from any source), the entire team will be reported to the honor code board and could fail the course. Team assignments require all members of a team to work together, to teach each other, and to learn from one another after each member of the team has worked individually on all problems. Each assignment is required to have the signature of each team member. Your signature means **"This assignment was completed 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 (live lectures): Your behavior in class should neither disrupt the class nor affect the ability of other students to learn. You will be required to sign a contract that commits you to the following rules:

- Not having a computer open in class, except a tablet that you write on with a stylus. You cannot type on a keyboard (including an on-screen keyboard) in class.
- Turning off your cell phone ringer and putting your phone away
- If you wear a smart watch, taking it off and putting it away
- 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 is one of the most important courses in the curriculum. Thermodynamics is used to determine the feasibility of a process. The concepts are used in subsequent courses (i.e., kinetics, biokinetics, 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.

This course will review the first and second laws; it will emphasize non-ideal properties of single-component and multicomponent systems; and it will devote a significant amount of time to phase equilibrium, which is important for separations (e.g., distillation, extraction, membranes, and absorption) and chemical equilibrium.

"A theory is more impressive the greater the simplicity of its premises is, the more different kinds of things it relates, and the more extended its area of applicability. Therefore, the deep impression classical thermodynamics made upon me. It is the only physical theory of universal content which, within the framework of the applicability of its basic concepts, I am convinced will never be overthrown." Albert Einstein

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

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

Expectations:

- Complete all reading quizzes on Canvas by **9 AM** on the day of the lecture.
- Watch all recorded lectures **on or before the scheduled day of class**. Note: You can watch the lectures at any time for review, but you must view them by the deadline to get credit for the embedded questions (to give you a buffer, the questions close at 1 AM on the day after class).
- Complete your weekly problem sets by **1 PM on Friday**, unless an alternative date is given.
- Participate by asking question on Canvas. You will receive **extra credit** for participation.
- To summarize, your major responsibilities are (i) reading the book, (ii) watching the screencasts, (iii) using the simulations, (iv) completing the reading quizzes, (v) viewing the lectures, and (vi) completing the homework. We will not spend time in lectures repeating material covered by the text. Instead, we will use class time to discuss the most important concepts, as well as applications and examples.

Resources to help you succeed in this course: Extensive resources on www.LearnChemE.com, including

- More than 375 thermodynamics screencasts (organized by topic and by textbook chapters)
- More than 85 interactive thermodynamics simulations with accompanying screencasts. They are organized by topic (<http://www.learncheme.com/simulations/thermodynamics>) and by textbook chapter (<http://www.learncheme.com/simulations/thermodynamics/elliott-and-lira>).
- More than 15 self-study interactive modules
- Extensive resources on how to study (<http://www.learncheme.com/student-resources/how-to-study-resources>)

Resources on Canvas

Canvas provides your daily schedule for this course (see lecture 1). We will also post course handouts, files, announcements, assignments, reading assignments, reading quizzes, screencasts, and links to interactive simulations. Canvas also contains chapter objectives/exam study guides and exams for the last two years.

Office hours (online): The instructors will hold one-on-one office hours on Monday at 10:00-11:00 AM (Smith) and 4:30-5:30 PM (Fox). We will hold help sessions on Wednesday (2:20-3:10 and 4:40-5:30) and Thursday (4:30-6:00). Office hours and help sessions are most effective if you come prepared with specific questions. You may also email us questions at jerome.fox@colorado.edu or wilson.smith@colorado.edu. **You must include CHEN3320 or the word thermo in the subject** in order to receive an answer. This will place your email in a folder for the course so that it can be more efficiently answered.

Prerequisites: Grades of "C-" or better must be obtained in CHEN4521 (PChem) and CHEN2120 (MEB).

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

Software: Canvas, Gradescope, and Zoom.

Grading: Homework assignments	15%
2 (evening) exams	35%
Concept test	10% or 5%
Canvas quizzes	10% or 5%
Final exam	30% or 40%
Participation	2% extra credit

Notes: The evening exam with the higher grade will count 20%, and the other will count 15%. **If the average of your two evening exams and final exam is lower than 52, the homework assignments will not count towards your course grade.** Instead, the percentages of the other items will be increased. Finally, note that there are two possible weightings to determine your grade, one of which emphasizes quizzes and concept questions, and one of which emphasizes the final exam. Your grade will be computed using both weightings, and the higher score will be used to determine your final grade. The fixed grading scale for the final course grade 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 Canvas under Exam Review modules) should be printed out and brought to the exams.* For exam 2, you should bring the equations for both exam 1 and 2. For the final exam, you should bring the equations for exams 1 and 2 and for the final exam. You must have your name on each page of the equations. Additional pages on Canvas (steam tables, physical properties, etc.) should also be brought to the exams. Please use a pencil that writes dark. Note that exams are from 6:30 to 8:30 PM on the scheduled dates. **NO MAKE-UP EXAMS WILL BE GIVEN.**

In class: Conceptual problems will be given every class. To allow for a few missed classes, the five days with the lowest percentage grades will be dropped when computing the “Concept test” grade. The class average for this grade has historically been in the 90's.

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 in a public Canvas 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 Canvas) before the start of the last class period.

Quizzes: A total of 10% of your course grade will be determined by responses to short quizzes related to the assigned reading and screencast viewing. **Quizzes must be completed independently on Canvas before 9 am** on the day of each class. These will generally consist of multiple-choice problems as well as a component where you submit a question or comment you have related to the reading. The goal of this latter component is to encourage you to actively engage the material, and to create an individual dialog between you and the instructor. We will use the quiz responses to prepare additional materials.

The question you ask us can concern any topic related to the assigned reading. You may also make comments about what you liked or did not like in the reading (be specific!), or ask questions about real-world applications of topics covered in the text. Be creative!! Questions or comments must be specific (“I don’t understand thermo” is not acceptable); the instructor will be the final judge of whether each question counts, and we will notify you if your question does not count and explain why. *We will often respond to your question on Canvas if we don’t think we will address it in class.* You may ask additional questions (for example, questions concerning material covered in the previous class) and we will also try to address it, but **it will not count as a sufficient response for the final component of the reading quiz.**

Assignments: Starting with assignment 4, students will work in teams of 3 people. Teams must submit a single set of solutions to Gradescope as high-quality PDF files. **Late assignments will not be accepted.** Remember to present your solutions clearly, leaving margins and space between problems. Write large enough so that the solutions can easily be read.

Teams: This year, you will be allowed to pick your teams. Each team must include three members of the same assigned section (i.e., 3320-001 or 3320-002). If you have trouble finding a group, please let Professors Fox and Smith know by the beginning of week 2; this deadline will allow them to assign you to a group long before the first group assignment is due. 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.

Every student must find a group. Teams will be asked to submit individual effort assessments at the end of the semester. These assessments will be confidential, and we will use them to adjust the HW grades.

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

- *Agree on a common meeting time and the responsibilities of each team member. Note: Zoom should make achieving common meeting times a bit easier.*
- *Complete the required individual preparation.* Before meeting, each team member should attempt to outline the solution of each problem.
- *Meet and work out the complete solutions to all assigned problems.*
- *Review graded assignments.* Make sure everyone understands why points were lost and how to correct errors.

Omitting names from assignments, firing, and quitting

- If a team member does not 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 Professors Fox or Smith) that he/she is in danger of being fired, and the team should meet with Professors Fox or Smith 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 Professor Fox or Smith).
- A student who is consistently doing most of the work on a team may issue a warning email (copy to Professor Fox or Smith) 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 Professor Fox or Smith) that he/she is no longer part of the team.
- *Students who are fired must find a team of 3 students unanimously willing to accept them as a member; otherwise they will receive zeroes for the remaining assignments.*

Teamwork 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. Please read the article [Coping with Hitchhikers.pdf](#).

ABET Student Outcome addressed by the course: an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Final exam policy: 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. Our final exam is scheduled for TBD.

Classroom Behavior. students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. 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 race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Code of Conduct](#).

Accommodations for Disabilities. If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

Requirements for COVID-19. As a matter of public health and safety in light of the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department, and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include the following:

- Maintain 6-foot distancing when possible,
- Wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- Clean local work area,
- Practice hand hygiene,
- Follow public health orders, and
- If sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert [CU Boulder Medical Services](#).

Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policies on [COVID-19 Health and Safety](#) and [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the “Accommodation for Disabilities” statement on this syllabus.

Before returning to campus, all students must complete the [COVID-19 Student Health and Expectations Course](#). Before coming onto campus each day, all students are required to complete a [Daily Health Form](#).

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home and complete the [Health Questionnaire and Illness Reporting Form](#) remotely. In this class, if you are sick or quarantined, simply send Professors Smith and Fox an email.

Preferred Student Names and Pronouns. CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Sexual Misconduct, Discrimination, Harassment, and/or Related Retaliation. The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious Holidays. Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please contact the instructors at the beginning of the semester if you have a conflict with one of the exams so we can make appropriate arrangements. See the [campus policy regarding religious observances](#) for full details.

Schedule 2020

CHEN 3320: Thermodynamics
Fall 2020

Department of Chemical and Biological Engineering

Office Hours

Wed 2:20-3:10, 4:40-5:30

Thu 4:30-6:00

Week	Date	Topic	Chapters	Instructor
1	Aug 24 – 28	Introduction, Course Organization, First Law	1, 2	Fox (1)/Smith (2)
2	Aug 31 – Sept 4	The Energy Balance	2	Smith
2	Sept 7	Labor Day: No Class	----	
3	Sept 9 – Sept 11	Energy Balances for Composite Systems, Entropy	3,4	Smith/Fox (4)
4	Sept 14 – Sept 18	Entropy	4	Fox
5	Sept 21 – Sept 25	Entropy and Processes, Generalizations for Any Fluid	5,6	Smith
6	Sept 28 – Oct 2	Equations of State, Departure Functions	7	Smith
Exam	Thursday, Oct 1	Exam #1, 6:30-8:30 PM, A108, A115, and/or online	1-5	
7	Oct 5 – Oct 9	Phase Equilibria	7,8,9	Smith
8	Oct 12 – Oct 16	Phase Equilibrium, Multicomponent Systems	9, 10	Smith
9	Oct 19 – Oct 23	Multicomponent Systems	10	Smith
10	Oct 26 – Oct 30	Activity Models, Phase Equilibrium	11, 14	Fox
11	Nov 2 – Nov 6	Phase Equilibrium, Partial Miscibility	14	Fox
Exam	Thursday, Nov 5	Exam #2, 6:30-8:30 PM, A108, A115, and/or online	6-11	
12	Nov 9 – Nov 13	EOS Approach to Phase Equilibrium, Chemical Equilibrium	14, 15, 17	Fox
13	Nov 16 – Nov 20	Reacting Systems	17	Fox
14	Nov 23 – Nov 25	Reacting Systems	17	Fox
14	Nov 27	Fall Break and Thanksgiving	----	
15	Nov 30 – Dec 4	Reacting Systems, Review	17, All	Fox
16	Dec 7	Review	All	Fox
Exam	Dec 10 (3320-01) Dec 12 (3320-02)	Final Exam, online, 1:30-4:00 PM and 7:30-10:00 PM*	All	

*We will try for a common final exam time, but these are our official times for now.