CHEN 3320: ChE Thermodynamics **Department of Chemical and Biological Engineering**
Fall 2024 **Kōnane Bay**
Revised Sept. 11 2024

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 Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), 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. Understanding the course's syllabus is a vital part in adhering to the Honor Code.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: StudentConduct@colorado.edu. Students found responsible for violating the Honor Code will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

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

- Using someone else's clicker in class or giving your clicker to someone else
- 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 team
- Presenting someone else's work as your own
- Submitting a team assignment in which you did not do all the problems
- Obtaining answers to on-line quizzes from someone or giving someone answers to on-line 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 name of each team member. Your name 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: 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
- 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:

- Attend all classes and be on time.
- Silence your cell phone and put your computers away during class.
- Participate in class. **You will receive extra credit for participation** (see below).
- Interact with on Perusall while you are viewing the screencasts, and working through the interactive simulations *before* class.
- Answer the quizzes and worksheets on Perusall *before* class.

To summarize, your major responsibilities are (i) reading the book, (ii) watching the screencasts, (iii) doing the simulations, and (iv) completing the homework. 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: Extra resources are on www.LearnChemE.com, including

- Approximately 400 thermodynamics screencasts (organized by topic and by textbook chapters)
- Approximately 100 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 30 self-study interactive modules
- Extensive resources on how to study (http://www.learncheme.com/student-resources/how-to-study-resources)

Resources on Canvas and Perusall

Before class, we will post slides that will have the clicker questions but not the answer for you to download. After class, we will post notes that contain both (i) everything written down in class and (ii) explanations of clicker questions. We will also post course handouts, files, announcements, assignments on Canvas. Reading assignments, screencasts, screen cast quizzes, and interactive simulations worksheets will be on Perusall. Canvas also contains chapter objectives/exam study guides and exams for the two recent years.

Office hours: We will hold group office hours on Wednesday (E1B11) at 4:00 – 5:30 pm and Thursday (A104) at 4:30 - 6:00. Individual office hours will be by appointment only. Office hours are most effective if you come prepared with specific questions. You may also email me questions at konane.bay@colorado.edu or ask them on Perusall. ***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.

Recitation: We will have optional recitation/review section selected Fridays at 9-10 am (dates TBA).

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

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).

Grading:	Weighting with Final Exam	Weighting w/o Final Exam
Homework assignments	10%	10%
Perusall Participation	10%	10%
In-class Concept questions	10%	10%
3 Midterm exams (weighted evenly)	45%	70%
Final Exam	25%	0%
Participation	2% extra credit	2% extra credit

Notes: Note that the final exam is optional **if you have an exam average of 82 or higher**. Therefore, there are several possible weightings to determine your grade.

For those who **do not take the final**, the three midterm exams will be weighted evenly. For those who **do take the final** if you score higher on the final than your lowest midterm exam score, the final exam grade will also replace your lowest midterm exam score.

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, and same for exam 3. For the final exam, you should bring the equations for exams 1, 2, and 3. You must have your name on each page of the equations, and you may make a few notes on the front of the pages. 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 on Fridays from 12:50 pm – 2:50 pm. **NO MAKE-UP EXAMS WILL BE GIVEN.**

In class: Conceptual problems will be given nearly every class. To allow for a few missed classes, the five days with the lowest percentage grades will be dropped when computing the Clicker grade. The class average for the clickers 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 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 they completed the above requirements. They must then *submit a signed form* (available on Canvas) before the start of the last class period.

Perusall Participation: A total of 10% of your course grade will be determined by your participation on Perusall on the assigned reading, screencast viewing, and simulation worksheets. **Must be completed before 11:59 pm** the day before each class. The goal of this is to encourage you to actively engage the material, and to create an individual dialog between you, your classmates, the TAs, and the instructor. We will use the responses before class to help identify the most important topics to cover during the class period.

Assignments: Starting with assignment 4, students will complete specified assignments in teams of 3 people. The group assignments are Assignment #4, 6, 7, 8, 9, and 12. ~~**Each person on the team will submit their own assignment in their own handwriting**~~**.** Teams must submit assignments 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. One assignment with the lowest percentage homework grade will be dropped when computing the final assignment grade.

Teams: We will use a software program to assign homework teams; in the first week of class, you will receive an e-mail with instructions to sign up for this program. 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 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.*
- *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.

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.

Artificial intelligence (AI) language models: Students are not allowed to use advanced automated tools (artificial intelligence or machine learning tools such as ChatGPT or Dall-E 2) on any assignment for this course. Each student is expected to complete each assignment without assistance from AI. Use of AI will be treated as a form of academic dishonesty akin to plagiarism or cheating.

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 4:30 PM on Saturday, December 16; it will not be the last exam.

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.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation: 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.

If you have a required medical isolation for which you require adjustment, email Dr. Bay to make the appropriate arrangements for missed lectures or exams.

Classroom Behavior: Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure 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, marital status, political affiliation, or political philosophy.

For more information, see the classroom behavior policy, the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

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Sexual Misconduct, Discrimination, Harassment, and/or Related Retaliation CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and support resources including confidential services can be found on the OIEC website.

Please know that faculty and graduate instructors must inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about resolution options and support resources. To learn more about reporting and support for a variety of concerns, visit the Don't Ignore It page.

Religious Accommodations: Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. 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.