Chemical Engineering Thermodynamics I

Class Schedule
MWF 8:30 am – 9:20 am in Jett Hall 283
Recitation/night exam time available: M 5:00-8:00 pm in Jett Hall 283. We will pick one hour of this time to use for recitation.

Instructor
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Catalog Description
Applications of the First Law and Second Law to chemical process systems, especially phase and chemical equilibria and the behavior of real fluids. Development of fundamental thermodynamic property relations and complete energy and entropy balances. 3 credits. Chemical engineering majors must earn a C or better in this course.

This class will prepare you to extensively study chemical equilibrium in CHE 302, understand and model physical properties in CHE 302L, and identify the contribution of energy and entropy balances in heat and mass transfer, separations, reactor design, and process control.

Pre-requisites
- CHME 201 and MATH 291G
We will frequently use mass and energy balances to solve thermodynamics problems, so I encourage you to review these concepts. We will also be solving first order differential equations using boundary and initial conditions, and some systems of equations (which may benefit from the use of MATLAB or similar software).

Textbook
- *Fundamentals of Chemical Engineering Thermodynamics*, Dahm, K.D. & Visco, D.P., 1st edition, Cengage Learning, 2015, ISBN 1-111-58070-7. You may use either the print or electronic versions of the textbook. By special arrangement with the publisher, we will have access to try the online supplemental material for free. I will provide more information about on the first day of class.
- Additional “readings” available on Canvas.
Course Objectives

- Enhance the students’ ability to perform material and energy balances.
- Provide an opportunity for students to develop an understanding of energy transformation limitations.
- Enable students to better use, predict, and produce thermodynamic data.
- Enable students to characterize and predict phase behavior.
- Provide an opportunity for students’ to develop an understanding of the quantitative aspects of chemical reaction equilibrium.
- Enhance the students’ ability to identify, formulate and solve engineering problems.
- Provide an opportunity for students to develop design skills for engineering unit operations using thermodynamic principles, and including consideration of safety and environmental concerns.
- Provide an opportunity for students to develop skill in the use of modern engineering tools.
- Provide an opportunity for students to work effectively as a member of team.

Course Learning Outcomes

By the end of this course, you should be able to:

- Use an engineering problem-solving strategy:
  - Identify the scope of the challenge or problem.
  - Draw a representation of the physical system.
  - Compile and evaluate known information about the problem.
  - Concisely describe what needs to be calculated or what criteria met.
  - List appropriate assumptions to simplify the problem.
  - Compile relevant property values and sources of information.
  - Apply conservation laws and rate equations in words and symbols/equations.
  - Calculate solutions to equations in general terms and with numerical values.
  - Use estimation to check reasonableness of assumptions and solutions.
- Define system boundaries.
- Calculate the heat requirement for a chemical or physical process.
- Solve problems using the appropriate energy balance.
- Calculate the work requirement for a chemical or physical process.
- Solve problems using the appropriate entropy balance.
- Evaluate, manipulate, and use ordinary and partial derivatives in solving thermodynamics problems.
- Determine the equilibrium conditions for chemical species transfer between phases (i.e. boiling, melting, freezing, etc.).
- Estimate property values for a chemical species at a given state (i.e. temperature, pressure, molar volume, etc.).
- Communicate thermodynamic concepts in the context of phase change and energy conversion processes, such as refrigeration, engines, and electricity production.
- Describe what changes about thermochemical properties when more than one chemical species is present (i.e. in mixtures).
Professionalism
This course is part of a chemical engineering curriculum designed to prepare you to be a professional engineer. As a professional-in-training, I have high expectations for your behavior including coming to class prepared and on time, completing assignments on time, asking questions when you do not understand, informing me ahead of time if you will miss an exam and taking responsibility for making it up, and communicating with respect, proper grammar, and attention to detail. You are expected to make the most of opportunities to collaborate with your colleagues in class and on assignments, but ultimately to do your own work and to acknowledge when you use material someone else prepared (i.e. avoid plagiarism). You can expect the same professional courtesy from me: being prepared and on time for class and office hours, informing you about changes in the schedule, giving feedback on assignments and exams in a timely manner (within 1 week), answering questions to the best of my ability, acknowledging when I make mistakes, being reasonable regarding absences and make-up exams/assignments, and giving my best effort to help you be successful in this course.

Team-Based Learning
This course uses the team-based learning method and will likely be very different from learning styles you have experienced before. Most of the “content” is covered individually outside of class as readings and pre-application exercise problems (Pre-App’s), and most of the application activities, conventionally done as homework and outside-of-class group projects, are done in teams during class. Teams will be determined the first day of class and will remain together the whole semester. To ensure that all students complete the readings and are prepared to do the in-class application exercises, daily quizzes (DQ’s) are taken by individuals and then by teams at the start of each day. The extent to which individual work and team work determine student grades is decided by the class. (For more information about the team-based learning strategy, please see www.teambasedlearning.org)

Assigned Readings and Reading Guides
Except for exam days, there will be assigned reading for every class meeting. I will strive to keep assignments under 10 pages and will provide a written reading guide for each reading. Reading guides and reading assignments from outside of the textbook will be available through Canvas. I put a lot of thought into selecting each reading and preparing each reading guide; I, and your teammates, will expect you to have done the readings before class.

Pre-Application Exercise Problems (PreApps)
The only way to be prepared to solve engineering problems is to practice solving engineering problems. You will be expected to know how to solve these kinds of problems as an individual on the exams in this course, in future courses, and on the job. Therefore, there will be one pre-application exercise problem (PreApp) at the end of every reading guide that you will be expected to complete before each class. PreApps will be collected at the beginning of class and graded. Late PreApps will only be accepted between the in-class collection time and 5 pm the day they are due for half credit. To account for unforeseen circumstances/unusually heavy workloads, I will drop your lowest three PreApp grades for the semester. You may turn in PreApps early to me or our TA, or ask a (trusted) team member to turn it in for you if you must miss class.
To get the maximum benefit from the PreApp problems, think carefully about how to solve the problems before getting help. Make an outline of how you would go about solving the problem. If you rely on the instructor or your classmates to "jump start" you on every PreApp problem, then you will have trouble with the exams.

Your PreApp problem solutions should be presented with a professional appearance: use grid or engineering paper, write clearly and legibly on only one side of the page, number your pages, show all of your work, box your final answer(s), and staple pages together.

Daily Quizzes (DQs)
As the beginning of every class, individuals and teams will take a 2-question quiz on assigned reading. The team quizzes are taken using an instantaneous feedback assessment test (IF-AT) method. We will practice taking a DQ on the second day of class. DQs are closed book and closed notes. As with the PreApps, I will drop each individual’s lowest three DQ grades at the end of the semester.

Exams
There will be two one-hour mid-term exams and a two-hour final exam during finals week. If possible, we will schedule the mid-term exams during the evening recitation time slot so that you will have plenty of time to finish. Exams will be mostly short-answer questions on concepts and relative magnitudes, with one or two calculation questions. The final exam will mostly cover material since the 2nd mid-term exam but may include a comprehensive question. All exams are open book and open notes. Prior approval from me at least a week ahead of time, or a certified medical/family excuse, is needed to make up a missed exam.

Communicating about Absences
If you need to miss a class due to an illness, professional travel such as a conference or interview, or a family emergency, let me know (email is fine) and your team members know as soon as possible so that any necessary arrangements can be made. You are responsible for getting any missed materials. Team DQs cannot be made up; individual DQs can be rescheduled with prior approval. All team members will get credit for the team DQs and in-class application exercises, present or not.

Grading
Scores in two major performance areas will be used to determine grades: individual performance and team performance. The percentage of the final grade for each performance area will be determined by representatives during the second class period. The procedure for setting grade weights will be as follows:

1. Student teams decide on weights and select a member to represent the team.
2. Team representatives meet in the front of the room and develop a consensus about the grade weights for the class as a whole.

Note: Team performance points will only count toward your course grade if you achieve at least a 70% in the individual performance category (and thus you have met the catalog requirement of passing the course with a C or greater as an individual).
Grade Weights

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<thead>
<tr>
<th>Category</th>
<th>Within Area</th>
<th>Overall</th>
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<tbody>
<tr>
<td><strong>Individual Performance (30-70%)</strong></td>
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<tr>
<td>Individual DQs (5-50%)</td>
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<td>PreApps (5-50%)</td>
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<td>Midterm Exams (20-50%)</td>
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<td>Final Exam (20-50%)</td>
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<td><strong>Team Performance (30-70%) x Team Contribution</strong></td>
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<td>Team RA Scores (20-40%)</td>
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<td>Application Exercises (40-70%)</td>
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<td>Problem Solving Critiques (10-30%)</td>
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The team contribution multiplier will be determined by peer evaluation. Individuals will evaluate the contributions their team members before the final exam by assigning an average of 10 points to the other team members. For example, members of a 6-person team:

- Split 50 points between the other 5 members.
- Must give at least one score >10 and at least one score <10.

Team contribution scores will be the average of the grades (out of 10) received. A “practice” team contribution evaluation will be done at mid-term so that students can receive feedback.

Final grades will be determined as follows: 0-59.9% = F, 60-69.9% = D, 70-71.9% = C-, 72-77.9% = C, 78-79.9% = C+, 80-81.9% = B-, 82-87.9% = B, 88-89.9% = B+, 90-91.9% = A-, 92-97.9% = A, 98-100% = A+. I will give all students a midterm grade estimation before March 11th (the last day to withdraw).

**Common Syllabus Addendum**
Additional policies can be found in the Chemical & Materials Engineering Department’s common syllabus addendum, available at http://chme.nmsu.edu/academics/syllabi/chme-common-syllabus-addendum/.

**Syllabus Preparation Date**
- 1/9/15