Spring 2022

CHE 342-002: Chemical Engineering Thermodynamics II

Richard Cimino

CHE-342-002 S22 Chemical Engineering Thermodynamics II

Instructor: Dr. Richard T. Cimino, Senior Lecturer

Office: 321C Tiernan Hall, Phone: 973-596-5729, E-mail: cimino@njit.edu

Class: Tuesday, Thursday, 2:30-3:50 PM; Face-To-Face

Room: Please check the NJIT Course Schedule for room
https://uisnetpr01.njit.edu/courseschedule/

Office Hours:

Office hours this semester are offered in two modes:

1.) Drop-in Hours: I am available in-person in my office on Wednesdays 9AM-2PM. You can drop in at any time to ask questions.

2.) WebEx Office Hours - **by arrangement only, Mondays and Fridays** - please sign up online at https://drcimino.youcanbook.me. WebEx office hours will take place using my personal WebEx room: njit.webex.edu/meet/ciminonjit.edu. Students are restricted to one 30 minute online office hours appointment per day. If you schedule more than one, only the earliest one will be honored and the rest will be canceled. Office Hours appointments must be scheduled at least 24 hours in advance of the appointment time, so that I have sufficient notice and can plan my day accordingly. Do not abuse this system, or it will be removed entirely.

Course Description and Requirements

The principles and methods developed in Chemical Engineering Thermodynamics I are extended to multicomponent systems, and used to treat phase and chemical equilibrium as well as such applications as chemical reactors and refrigeration systems.

Prerequisites: ChE 230, Math 211 (or Math 213), Chem 236

Corequisites: None

Course Objectives

Taking this course, a motivated student will learn to:

1. Apply Raoult's law and Henry's law to solve thermodynamics problems
2. Predict behavior from liquid/vapor phase diagrams including azeotropes

3. Carry out bubble and dew point calculations for a given mixture
4. Calculate partial properties of binary solutions, such as partial molar volumes
5. Calculate activity coecients using correlating equations such as Margules and Lan Laar
6. Determine VLE using ideal gas and ideal solution models
7. Analyze appropriate models for calculating phase equilibrium
8. Interpret phase diagrams of binary systems
9. Calculate vapor-liquid equilibria for non-electrolyte systems
10. Predict equilibrium compositions of mixtures under phase equilibria
11. Apply concepts of equilibria of multi-component, multi-phase systems to the evaluation and design of separation processes, such as flash distillation
12. Estimate the fugacity coecients for given mixtures
13. Analyze ideal gas/solution models that reflect behavior of real mixtures based on concepts
    of excess free energy and chemical potential mixtures.
14. Describe chemical reaction equilibrium using the extent of reaction and fugacity, as functions of temperature and pressure.

Learning Materials

Textbook

Required: Required: Fundamentals of Chemical Engineering Thermodynamics, Kevin D. Dahm, Donald P. Visco (2014). ISBN: 1111580707

Calculator: A graphing calculator (TI-83, TI-84 or TI-84SE) is required for solving numerical problems.

Required Hardware:

A working computer running Windows and having MS Excel installed. We will also be using Aspen to generate binary VLE data. ***Apple and/or Linux systems are not recommended for this course if you intend to run ASPEN on your own computer (need to dual boot or use a virtual machine with Windows). If you do not own a PC, you are welcome to utilize the computer labs to complete ASPEN-related assignments.***

Course Outline

Week Date(s) Topic (preliminary, subject to minor changes)

CHE-342-002 S22 Chemical Engineering Thermodynamics II

		Recollection of Thermo I
1	**1/18-20**	**Ch. 8**
		Pure Component Phase Eq. - Gibbs Free Energy
		Pure Component Phase Eq. - Vapor Pressure
2	**1/25-27**	
		Chemical Potential & Fugacity
		Poynting Method
4	**2/1-3**	**Ch. 9**
		Introduction to Mixtures
		Properties of Mixing
5	**2/8-10**	
		Partial Molar Properties
		Partial Molar Properties of Binary Mixtures
6	**2/15-17**	**Ch. 10**
		Raoult's Law
		Exam 1 Review
6	**2/15-17**	
		Exam 1
		Bubble and Dewpoint Calculations,
7	**2/22-24**	
		Binary Pxy,Txy, and X-Y diagrams and ASPEN
		Binary Pxy,Txy, and X-Y diagrams and ASPEN
8	**3/1-3**	
		Binary Flash Separation - Analytical Soln w/Raoult-Antoine
		Binary Flash Separation - McCabe-Thiele Solution
9	**3/8-10**	
		Multicomponent Flash - Ratchford-Rice Equation
10	**3/15-17**	**Spring Break, No Classes**
		Ch. 11
11	**3/22-24**	**Phase Eq. of Mixtures, Mixture Fugacity**
		Raoult/Henry for Mixtures
		Exam 2 Review
12	**3/29-31**	
		Exam 2

CHE-342-002 S22 Chemical Engineering Thermodynamics II

13	**4/5-7**	**Gibbs Free Energy Models, 1 & 2 param Margules eqn** **Data Reduction using Margules** **Term Project Day**
14	**4/12-14**	**Regular Solution Theory - Wilson & Van Laar Eqns** **Ch. 14**
15	**4/19-21**	**Review of Reactive Material Balances** **Chemical Reaction Equilibrium** **Chemical Reaction Equilibrium**
16	**4/26-28**	**Final Exam Review**

Assessment and Grading

Homework/Practice Problems: Regular Homework/Practice Problems will be assigned each week. These assignments are mandatory, but are graded for completion only (and not correctness). Performing and understanding the practice problems will be crucial for the weekly quizzes. You are encouraged to work in groups to complete these assignments.

Quizzes: Regular in-class quizzes will be given regularly based on the weekly material. In order to prepare for these quizzes, each week has a set of Practice Problems that you can use to practice. No make-up quizzes will be allowed.

Exams: There will be two midterm exams (80 min long) and one final exam (2.5 hours long). All exams will be open book/open note.

Project: Towards the end of the semester, there will be a team-based term project on modeling the VLE of mixtures. This project will require a brief report which must follow the formatting in the CME style guide (see CME Style Guide here (Links to an external site.))

CHE-342-002 S22 Chemical Engineering Thermodynamics II

Grading: Your final course grade will be calculated by weighted average, using the following weights:

Category	Weight
Homework & Quizzes	**25%**
Project	**10%**
Midterms (x2)	**40%**
Final Exam	**25%**
Total	**100%**

Final course grades will be assigned according to the following rubric:

Lower Bound	Letter Grade	Upper Bound
90	**A**	**100**
85	**B+**	**89**
80	**B**	**84**
75	**C+**	**79**
70	**C**	**74**
60	**D**	**69**
0	**F**	**60**

Important Dates

Add/Drop: Monday Jan. 24th

Withdraw Deadline: Monday Mar. 7th

Final Exam: TBA - Please check here again soon.

Policies

NJIT Honor Code: The NJIT Honor Code will be upheld and any violations will be brought to the immediate attention of the Dean of Students.

CHE-342-002 S22 Chemical Engineering Thermodynamics II

Special Needs: If you need accommodations due to a disability please contact OARS, Fenster Hall Room 260 to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.

Lectures: This course is a face-to-face course. This means that each lecture will take place in-person during the class hours. Attending the sessions in person is strongly recommended. Failure to attend may result in being marked as "unattended" for the course, which may negatively impact your financial aid status. Additionally, quizzes will take place in-class, so failure to attend could result in zeros on quizzes. Additionally, the examples discussed in the class are not necessarily from the main textbook and therefore missing a class will have consequences for your preparation for quizzes and exams. ***Note, if at any point the course is forced to go converged or completely online due to COVID-19, you will be provided with additional information on how to access the course lectures.***

Classes start at 2:30 PM, and students must be in the classroom by that time. Being late to class may have consequences for your final course grade.

No audio or video recording is allowed.

Cellphones should be turned off during both lectures and exams and not allowed under any circumstances.

Course materials, office hours and correspondence

The course Canvas page is the main platform for delivering information about the course. All relevant course materials and assignments will be posted on Canvas, so a student should check it regularly.

Students must upload a professional-looking head shot for their Canvas profile.

CHE-342-002 S22 Chemical Engineering Thermodynamics II

Students are strongly encouraged to attend Office Hours. Long questions which require derivations will be discussed only during the Office Hours and will not be answered by email. Questions regarding grades can be discussed only during the Office Hours.

E-mail and Canvas correspondence is intended only for quick questions. Questions which require a detailed discussion should be discussed in person during the Office Hours.

All correspondence should be conducted in a professional style, using formal English.

To assure a quick response to your emails, please add "ChE342" in the subject of your emails.

The instructor reserves the right not to respond to emails at his personal discretion.

Exams, Quizzes and Grades

A letter grade is based on the final score, calculated using Canvas in accordance with the Tables given in this syllabus. The assigned letter grade is final and cannot be negotiated.

A student can dispute the exam scores within a week after the announcement of the score. Exam scores can only be disputed during the official Office Hours, not during class time or via email.

Students will get zero for not coming to quizzes, exams, or any other course activity. If students miss an exam due to extreme circumstances (such as a medical problem), they need to notify the instructor via email before the beginning of the exam, and bring proof of the circumstance to the Dean of Student's office. Only in the case of official approval from the Dean of Student's office, may a make-up be given at the discretion of the instructor.

CHE-342-002 S22 Chemical Engineering Thermodynamics II

A student must show full details when solving a problem during an exam or a quiz. Not showing the work will cause the losing points even if the final answer is correct.

Partial credit can be given for solving the exam and quiz problems, though no partial credit will be given if there are not enough details to follow.

The final answer should be always evaluated with respect to its reasonability. No partial credit will be given if the final answer is wrong and unreasonable, and it is not stated.

If a student misses a quiz due to a legitimate reason (absence approved by the Dean of Students), this quiz is excluded from the quiz average calculation.

Student handwriting must be legible in order to receive points.