CH E 320 – Summer 2019
Phase and Chemical Equilibrium

https://psu.instructure.com

Course Information

3 credits; prerequisites: CH E 210 with C or higher; CH E 220 with C or higher. A grade of C or better in this course is required for a degree in chemical engineering.

Instructor

Dr. Themis Matsoukas (txm11@psu.edu).

Teaching Assistant

To be announced.

Web

The course is run entirely on Canvas (https://psu.instructure.com). All lecture material, announcements, homework and course correspondence will be conducted via Canvas. Please do not email questions to the instructor unless you want to discuss private matters (grades, performance, personal issues etc.).

Textbook

T. Matsoukas, *Fundamentals of Chemical Engineering Thermodynamics*, Prentice Hall (Required).

Objectives

In this course you will learn how to calculate the thermodynamic properties and phase behavior of mixtures composed of two or more components. You will apply this knowledge to vapor/liquid separation, absorption of gases in liquids, solvent recovery and purification, and chemical reactions. The material in this course is relevant in ChE 410 (separations), ChE 430 (chemical reactors) and in the capstone design course (CH E 470).

By the end of this course you will be able to:

1. read and calculate phase diagrams of binary and ternary systems
2. calculate fugacity in liquids and gases
3. use of equations of state for the properties and phase behavior of mixtures
4. use activity coefficients to construct phase diagrams
5. do calculations with partially miscible liquids
6. perform preliminary design of simple separation units
7. use standard states for the calculation of equilibrium constants
8. calculate compositions in chemical reactions that reach equilibrium

In addition, the course requires teamwork, technical writing, numerical skills, and a level of independent learning through literature searches and open-ended problems. General guidance on teamwork and technical writing and numerical computing will be provided but students are expected to have a basic level of proficiency with these skills.

Homework

- Weekly homework will be posted each Monday on Canvas and will be due the following Sunday at 11:59 PM EST.
- Homework will be submitted on Canvas as a PDF document by the due date. No late homework will be accepted except for extraordinary circumstances. If you expect to be unable to meet the deadline you must discuss the situation with the instructor ahead of time.
- Each student must submit his/her own copy of the homework; photocopied homework, identical computer printouts or otherwise suspiciously similar work will receive a grade of zero.
- Homework will be assigned but not collected on exam weeks.

- The lowest homework score will be dropped in the final calculation of the grade.

Rules for submitting homework:

- Each homework assignment must be submitted as a single PDF document. PDF is the only acceptable format. You may scan your handwritten solution but the scan must be legible.
- The first page of the homework is the cover page and must show your name and assignment number.
- A typical homework set will contain four problems. The solutions should be given in the order of the problems in the problem statement. Each problem should be identified (e.g., Problem 1,Problem 2 etc) and its solution should begin on a new page.
- Do not submit raw spreadsheets or Mathematica notebooks. You may use excel, Mathematica or other computational tools in the homework but your solution should be a *narrative* that explains the calculation in words.
- When a problem asks for graphs, they should be done by computer. Graphs should be properly annotated and should contain no hand-written material. A tutorial on making good graphs is posted on Canvas.
- The solutions you submit must be legible and all relevant information ought to be presented.
- Homework that does not follow these guidelines may receive a zero grade without review of the contents.

Exams

Exams will be based on the material covered in the lectures, textbook, handouts and homework. There will be *three* exams (two midterms and one comprehensive final). The midterm exams will be based on the material covered since the previous exam. The final will be based on the entire course with an emphasis on the most recent material.

The dates of the exams will be announced later this spring.

All exams are open *book* exams. Only the required textbook is permitted. Personal lecture notes and homework solutions are not allowed in the exam. The final exam is comprehensive.

No make up exams will be given except for serious, documented reasons. If you have an exam conflict, please see Prof. Matsoukas by the end of the first week of classes.

To receive consideration for reasonable accommodations due to disability you must contact the Office for Student Disability Resources, participate in an intake interview, and provide documentation. If the documentation supports your request the disability services office will provide you with an accommodation letter. Bring this letter to your instructor as early as possible to discuss and plan alternatives.

Exam Proctoring

All exams will be proctored via examity.com. Students at University Park may arrange to take a proctored exam on campus. Additional information will become available on Canvas upon the beginning of the course.

Grading

The final grade will be based on a weighted average calculated as follows:

Homework:	15%
Three exams:	85% (all exams are equivalent)

A final score of 90 and above will guarantee you an A; 85 and above an A-; 80 and above a B+; 75 and above a B; 70 and above a B-; 65 and above a C+; 60 and above a C; 50 and above a D; below 50 is F.

Academic Integrity

Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. It includes a commitment by all members of the University community not to engage in or tolerate acts of falsification, misrepresentation or deception. If Academic Integrity is breached the trust between teacher and student dissolves and the purpose of education is compromised. When this happens, the reputation of the school and the value of the degree you seek are diminished, not only for those involved in acts of deception, but for all of us.

It is not possible to enumerate all acts that violate Academic Integrity but here are a few that you should be aware of:

- *Cheating in exams is a very serious offense*. It includes copying from others with or without their consent, using unauthorized resources, communicating with others during the exam, having prior knowledge of the exam problems, or otherwise presenting work done by others as yours. I take this offense very seriously not only because it disrespects the entire premise of education, but because it is offensive to all other students, whose hard work is undermined by the cheater. The sanction for cheating in an exam is a grade of F in the course and I will pursue it by all means available under University policies. Three students in a recent summer class I taught were caught cheating and received an F in the course.
- Copying homework solutions from the solution manual or from online services is a breach of Academic Integrity. It is also foolish, as it would be if one begged someone else to go to the gym and lift weights for them. The purpose of the homework is to give you practice on the material you need to know and on the material that you will see in the exams. By missing the opportunity to practice the exam will seem much tougher. The sanction for copying homework solutions is a zero in that homework problem but the true price is poor performance in the exam.
- The material distributed in the course is copyrighted by the instructor. This includes lecture notes, homework and exam problems as well as all other material posted on canvas. Sharing this material outside class (with online tutoring services, for example) is not permitted, regardless of whether you have obtained the solution or not.
- Being truthful when you seek special accommodations such as extensions in assignments or special makeup exams is a matter of Academic Integrity. Special treatment may be given only for serious reasons or emergencies with the understanding that you represent the situation truthfully.

Please familiarize yourselves with the University Policies on Academic Integrity and the procedures when a case is initiated. If you are not sure whether an action is permitted under Academic Integrity, talk to the instructor —just because an offense is not mentioned here explicitly does not mean that it is permitted.

LIST OF TOPICS

Date	Lecture	Chapter	Topics
13-May-19	1	7	Review of 220; two-phase systems; Gibbs energy
14-May-19	2	7	Saturation point; Clausius-Clapeyron
15-May-19	3	7	Fugacity and fugacity coefficient
16-May-19	4	7	Calculation of fugacity
17-May-19	5	7	Fugacity from cubic EoS; stability; review of Ch. 7
20-May-19	6	8	The Txy graph, lever rule
21-May-19	7	8	Pxy, azeotropes, partial miscibility
22-May-19	8	8	Review examples in Ch 8
23-May-19	9	9	Multicomponent calculus; composition
24-May-19	10	9	Properties of mixing, ideal gas mixture
27-May-19			Memorial Day Holiday - No Classes
28-May-19	11	9	Mixing and separation; processes with ideal gas mixtures
29-May-19	12	9	Properties of mixtures using EoS
30-May-19	13	10	Chemical potential, fugacity
31-May-19	14	10	VLE from EoS
3-Jun-19	15	11	Ideal solution; properties of mixing; Raoult's law
4-Jun-19	16	11	Bubble and Dew calculations
5-Jun-19	17	11	Flash calculations
6-Jun-19	18	11	Multicomponent VLE
7-Jun-19	19	11	Multiple flash units
10-Jun-19	20	11	Enthalpy; real and hypothetical states
11-Jun-19	21	12	Excess properties
12-Jun-19	22	12	Heat effects
13-Jun-19	23	12	Activity coefficients
14-Jun-19	24	12	Activity coefficients from experimental data
17-Jun-19	25	13	VLE using activity coefficients
18-Jun-19	26	13	Activity coefficient models
19-Jun-19	27	13	UNIQUAC/UNIFAC
20-Jun-19	28	13	Stability, partial miscibility
21-Jun-19	29	13	VLE with partial miscibility examples
24-Jun-19	30	13	Fully immiscible liquids
25-Jun-19	31	13	Henry's law
26-Jun-19	32	13	Examples
27-Jun-19	33	14	Stoichiometry and standard states
28-Jun-19	34	14	Enthalpy of reaction
1-Jul-19	35	14	Energy balances with reactions
2-Jul-19	36	14	Relating enthalpy to standard state
3-Jul-19	37	14	Relating Gibbs energy to standard state
4-Jul-19	38		Independence Day Holiday- No Classes
5-Jul-19	39	14	Equilibrium constant.
8-Jul-19	40	14	Equilibrium constant–effect of temperature
9-Jul-19	41	14	Equilibrium at any P, T
10-Jul-19	42	14	Reaction equilibrium and VLE
11-Jul-19	43	14	Gas-solid equilibrium
12-Jul-19	44	14	Multiple reactions
15-Jul-19	45	14	Review
16-Jul-19	45	14	Study day
17-Jul-19	45	14	Study day
18-Jul-19	45	14	Exam window
19-Jul-19	45	14	Exam window

Last updated: February 20, 2019