ChEE 326
Chemical and Physical Equilibrium
Spring 20XX
University of Arizona

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Instructors' Availability:
The instructor and teaching team will be available by appointment and students should post to piazza privately or publicly when they are available and the instructors will respond after communicating with each other and the teaching team.

Formal office hours will also be posted on the D2L class site.

Active Learning Environment: Days / Time / Location TBD

Teaching Assistant: XXXX

Instructional Manager: XXXX

This person is who you email if you have clicker issues, if you miss the dropbox for an assignment, if there is an emergency, if you have issues outside of homework or exams. They will do a first response.

Communicating with the Teaching Team Outside of Class:
Use the piazza discussion board to ask questions about the course or course content:
https://piazza.com/arizona/spring2019/chee326
The settings on Piazza allow posts to remain private to the instructor and this should be used instead of emailing the instructor directly.

Course Description:

This course will introduce you to the fundamental principles of chemical process equilibrium analysis. It will equip you with problem solving techniques and will give you experience in the application of these techniques to a wide variety of process-related problems.

Text: *Introductory Chemical Engineering Thermodynamics*. J. Richard Elliott and Carl T. Lira, second edition, ISBN 978-0-13-606854-9

Elementary Principles of Chemical Processes, 4th Edition, R. M. Felder and R. W. Rousseau, John Wiley and Sons, 1998 or 2005.
(Same Textbook used for ChEE 201)

Communicating With the Teaching Team Online:
Piazza will be used for all questions and students should obtain a free account at piazza.com and then be able to link to our class. Students who answer questions will earn up to 2% extra credit towards their final grade. Before asking a question, please check that someone has not already asked/answered the same question. Preceptors will also be monitoring the piazza discussions and commenting. You can join the discussion board here: http://piazza.com/arizona/spring2020/chee326

In order to foster collaboration, no one on the teaching team will respond to a post until someone else from the class posts a response or attempts to help.

Course Objectives:
Upon completion of this course, students should:
1) be able to solve thermodynamics problems using both hand and computer programming techniques, building on ChEE 201, 202, 203, and 303.
2) be able to apply fugacity to estimate ideal and non-ideal properties of substances
3) be able to construct phase diagrams for ideal and real mixtures of gases, liquids, and solids
4) be able to construct and use a model of phase behavior using limited experimental data for VLE, LLE, and SLE
5) be able to formulate and solve chemical reaction equilibrium calculations that may include multiple reactions
6) be able to use ASPEN to simulate various equilibrium processes and to be able to verify the simulated results are correct

Other metaconcepts the students should be proficient at:
1) be able to comfortably organize and present group or individual material to the class
2) be able to add equilibrium thermodynamic knowledge to your existing framework of chemical engineering problem solving techniques
3) be able to identify personal difficulties during problem solving and to take corrective action
4) be able to knowledgeably think of everyday examples where equilibria are important
5) be able to search for and use information from published sources

Absence and Class Participation Policies:
Class and supplemental attendance are not optional for this class. Unlike some classes where students passively copy notes, the activities done in class are critical to student success. Class attendance will be verified with a clicker question that appears at some point randomly in the day's activities and will be auto-recorded through that device. If you do not have a clicker, please get one as quickly as possible from the UA Bookstore or purchase a license for TurningPoint ResponseWare. Clickers will also be used to gauge understanding of reading material, support class discussions, facilitate understanding of new concepts and review previously taught material.

If you forget your clicker, please take a picture of your notes from that day, email the picture to nickofca@email.arizona.edu and report the class and date in the subject so you can receive attendance points. If you miss class, you can watch the recording in Panopto in UA Tools on D2L and then email the same email address to earn 75% of the attendance points.

Absences for any sincerely held religious belief, observance or practice will be accommodated were reasonable: http://policy.arizona.edu/human-resources/religious-accommodation-policy

Absences pre-approved by the UA Dean of Students (or Dean's designee) will be honored.

Required Texts or Readings:

Introductory Chemical Engineering Thermodynamics. J. Richard Elliott and Carl T. Lira, Second Edition, ISBN 978-0-13-606854-9

Elementary Principles of Chemical Processes, 4th Edition, R. M. Felder and R. W. Rousseau, John Wiley and Sons, 1998 or 2005.
(Same Textbook used for ChEE 201)

Course Prerequisites:
The courses you must have taken before this course are ChEE 303 and CHEM 480a.

Course Website: D2L website for ChEE 326

Important Dates to Keep in Mind:
All dates and deadlines regarding registration, dropping, GRO'ing, etc. can be found at
https://www.registrar.arizona.edu/courses/dates-deadlines

Required or Special Materials:
We will be using Turning Technologies Clickers and/or responseware for class extensively for both attendance and for helping the teaching team see where students need more help in mastering the content of the course. A link here helps remind students of details on how to get registered and set up: https://oia.arizona.edu/content/19

Required Examinations and Assignments:
There will be three midterm exams, approximately 11 homework assignments, and one final exam. Each midterm exam will be split into a group portion and an individual conceptual and individual calculational portion. Detailed dates are provided in a schedule later.

Required Extracurricular Activities:
None

Grading Scale and Grade Policies:
This section will highlight the breakdown of major graded elements first, then detail the grading scale, and then get into details.

Course Grading Policies:
This section details the graded elements of the class, first in a big picture way and then in detail.
Big Picture View of Graded Elements

Individual	HW	due weekly	15%
Group	HW	due weekly	5%
Pre-Class Quizzes		due daily	10%
Attendance		due daily	10%
Midterm		Exams: 3 times/sem	30%
Group Presentation		1 time/semester	5%

Final Project	end of semester	10%
Final Exam	end of semester	15%
Total		100%

Teamwork is required in all engineering jobs and we will start building your skills in this area by working in teams inside and outside of class. You should help your classmates master content even as you ask questions of them when you are stuck. To help your team, make sure you attend class, do the pre-quizzes, and work with them. You will find that the group homework will not be solvable by one person so certainly work with your team on those activities.

<u>Homework: (15% of grade for individual problems + 5% for group team problems)</u>
Individual homework is due at the ***<u>beginning</u>*** of the class on the day it is due to the dropbox for that day. Late homework will be accepted with a 10% late penalty until 10:59 pm on the day it is due. A clear scan, picture from your device, or other clear materials will be acceptable. Each week, one problem will be graded for detail and will make up the bulk of the points for the individual homework grade, while the other problems will be assessed for completion and be worth 10% each for making a good attempt. The problem graded in detail will be selected at random from the week's set of cumulative problems.

Group HW will be due once a week and will typically be the one or two toughest problems from each set of concepts will be due each week and is a group mastery problem that you will solve together in your learning teams. Each person on your team should submit a full copy of the group's solution with all names to their own dropbox. These problems will be graded for detail.

Also, the group presentations in class will be a part of the 5% for group homework. For more information, visit the course site.

To eliminate confusion and difficulties in staying current, students will have 1 week from the date homework, quizzes, or exams are returned to discuss grading criteria and scores with the instructor or regrader. After the 1 week time limit has passed, students will not be able to petition for changes to their grade. All regrade requests must be done through the Regrade Form posted on the d2L site.

<u>Pre-class Quizzes on D2L: (15% of grade)</u>
There are many elements of being ready for new topics and part of that is to do the class readings ahead of time so you are ready for what happens in class. The online quizzes developed to help you be ready for class will make up 10 % of the grade and you will have three attempts on each quiz and your highest score will be the one recorded. These quizzes are designed so students will know the most important details from each reading section. If you want to efficiently study, open the quiz and start reading, looking for the details the questions ask you to notice, and take notes on the details. You'll quickly find out that the quizzes are randomized and if you are unhappy with your score and retake, that you get a new set of questions that cover the same content in a slightly different way. You'll be faster if you take the quiz seriously the first time.

To maximize learning in the pre-quizzes and to foster long term retention of the content, you should take notes on the questions and answers. Four times during the semester, you will randomly be selected by a preceptor and you'll have to show your notes from the pre-quiz. This grade will go in to your overall XX grade and will ensure that you have prepared well enough to help your team during the activities that day in class.

<u>Attendance (10% of grade)</u>

An active learning environment involves everyone working together to help master the content. Points will be assigned for attendance for each lecture based on use of your clicker/responseware during class, but up to two missed days will be dropped for each student. If you were present on a day in class and did not have your clicker, email a scan of your notes to that day to the TA, clearly telling them which lecture numbe and the date, and include some portion of your notes for that date.

Exams (three exams, 10% each, 30% of grade total).

These in-class exams are **comprehensive** and are scheduled on later pages. Unless otherwise announced, these exams will be open book. The exams will have three pieces:

A group exam that will be paper and Excel-based (35 % of the exam grade)

An individual calculational exam that will be paper and Excel-based (50% of the exam grade)

And, an individual conceptual exam that will be in d2l and worth 15% of the exam

Make-up exams: There will be no make up exams. If a student has a valid medical or emergency excuse, the missed exam grade will be replaced by the average of the other midterm grades.

Final Project: (10% of grade):

Due with two separate pieces at the end of the semester.

Four people will be assigned per team. See content on course site for more information.

Extra credit: (up to 1% increase in final grade)

Students who answer other students' questions posted to the piazza discussion board can earn up to 1% extra credit towards their final course grade, at the discretion of the instructor.

Possibility of Dropping some Scores Based on Class TCE Response Rates:

If 80% of the class completes the Teacher Course Evaluation at the end of the semester, then the lowest two pre-quiz D2L grades will be dropped for every student in the class.

If 90% of the class completes the Teacher Course Evaluation at the end of the semester, then the lowest individual HW score will be dropped.

Final exam: (20% of grade)

Final exam policies are described here:

https://www.registrar.arizona.edu/courses/final-examination-schedule-spring-2020

and will be followed in this class.

The final exam is scheduled for (day / time / location TBD).

https://www.registrar.arizona.edu/courses/final-examination-schedule-spring-202X

Plagiarism: Although this course is not writing intensive, plagiarism is unacceptable. The plagiarism policies within the Student Code of Academic Integrity will be strictly followed: http://doc.web.arizona.edu/uapolicies.

Threatening Behavior: The general policies against threatening behavior by students will be followed: http://policy.web.arizona.edu/~policy/threaten.shtml

Inclusivity: This course supports elective gender pronoun use and self-identification; rosters indicating such choices will be updated throughout the semester, upon student request. As the course includes group work and in-class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect

Grading Rubric:
Letter grades on exams or assignments will not be determined; a final letter grade will be given at the end of the semester instead. This course will be graded on a straight scale as follows:

Total percentage of points	earned	Final Grade
90 - 100 %		A
78 – 89.999 %		B
66 – 77.999 %		C
54 – 65.999 %		D
< 54.999%		E

Classroom Behavior Policy
Developing your ability to effectively work in teams is an important aspect of this course, so you will regularly work in small groups in class, and you will complete weekly group homework and take group exams. You will be expected to look up information on the e-text or on websites. The teaching team will help remind you not to text or be using your devices for other reasons. You will be expected to respectfully work with all teammates and to be supportive of each other when you struggle with the content.

Threatening Behavior Policy
The general policies against threatening behavior by students will be followed:
http://policy.web.arizona.edu/education-and-student-affairs/threatening-behavior-students

Academic Integrity Policy
Plagiarism in any form, including copying the work of another student, will not be accepted. The plagiarism policies within the Student Code of Academic Integrity will be strictly followed: https://deanofstudents.arizona.edu/policies-and-codes/code-academic-integrity. Clicking in for another person is a form of academic dishonesty and will be dealt with according to the same guidelines.

Nondiscriminatory and Anti-harassment Policy
UA policies list prohibited behaviors here:
http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Accommodations for Students with Disabilities
Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit http://drc.arizona.edu.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate. Please be aware that the accessible table and chairs in

this room should remain available for students who find that standard classroom seating is not usable.

Schedule of Topics and Activities
The schedule appears at the end of this document in concise form.

Standards for Homework Problems and Quizzes:
1. Briefly restate the problem using a sketch or diagram where appropriate. Label the sketch or diagram with all quantities involved.
2. Indicate the basis you select, and indicate any change of basis within the problem. State assumptions.
3. Include both the numerical value and units for all quantities involved, including intermediate results.
4. Answers should be circled or otherwise marked, and reported to an appropriate number of significant digits.
5. Values obtained from a handbook or other reference should be accompanied by a citation. For example:

$$CCl_4 \text{ boiling pt. } 76.5 \,^{\circ}C \text{ (CRC, pg C-373)}$$

6. Show how you have checked your work if appropriate.
7. Be clear and concise when writing answers to questions.

Substandard work will result in a loss of credit.

Standards for Style and Presentation of Problem Sets:
1. All assignments are to be submitted by scans with all Excel/Matlab files used with clear annotations on those materials on how answers were arrived at. Each homework should be submitted in one submission with as many files as you needed to use. . Handwriting must be legible.
2. Each page must have the students' names and group number, the course number, and the page number in the upper right-hand corner.

   Substandard work will result in a loss of credit.

Changes to the Syllabus: The information contained in the course syllabus, other than the grade and absence policies may be subject to change with reasonable advanced notice as deemed appropriate by the instructor.

ChEE 326 Spring 2019 Class Schedule (subject to change - check D2L for updates)

Week	Lec #	Date	Day	Reading Assigned	Homework Due	Pre Class Activities	Topic
1	1	xxx	x	None		**Presentation Skills Survey**	Importance of this Class to ChEE
	2	xxx	x	Sec 6.0-6.2		**Post L2 Quiz PL2 Quiz**	Generalized equations for any fluid
2		xxx	x	MLK Day – No Class	Resume	**Resume Review Quiz**	
	3	xxx	x	Sec 7.0-7.5	**HW 1**		PVT and EOS
	4	xxx	x	Sec 7.6		**PL 4 Quiz Post Lecture 3 Recording**	Solving cubic EOS Departure functions
3	5	xxx	x	None			Departure functions
	6	xxx	x	Sec 8.0-8.10	**HW 2**	**PL6 Quiz (keep here?)**	Departure Functions 2
	7	xxx	x	Sec 9.0- 9.3		No Quiz (Create one?)	Clausius-Clapeyron Equation
4	8	xxx	x	Sec 9.4-9.7		**PL8 Quiz**	Equilibrium
	9	xxx	x	Sec 9.8-9.9	**HW 3**	**PL 9 Quiz**	Clausius-Clapeyron Equation
	10	xxx	x	Sec 9.10-9.13		**PL 10 Quiz**	Gas phase fugacity
5	11	xxx	x			**PL 11 Quiz**	Gas phase fugacity from EOS
	12	xxx	x	Sec 10.0-10.2	**HW 4**	**PL 12 Quiz**	Liquid fugacity
	13	xxx	x	Sec 10.3-10.4	Test 1 Group		Group Exam 1
6	14	xxx	x		Test 1 Individual		Individual Exam 1
	15	xxx	x		HW 5		Modified Raoult's Law Introduced
	16	xxx	x	Sec 10.5-10.8		**PL 16 Quiz**	Intermolecular forces
7	17	xxx	x	Sec 10.9-10.13		No Quiz	VLE: Residuals
	18	xxx	x	Section 11.0-11.2	HW 6	PL 18 Quiz	VLE: One parameter Margules derivation

	19	xxx	x			No Quiz	VLE: One Parameter Margules application
8	20	xxx	x			No Quiz	Thermodynamic Consistency
	21	xxx	x	Sec 11.3-11.5		PL 21 Quiz	
	22	xxx	x			Interactive Recording on Two Parameter Margules	VLE: Margules two parameter
		xxx		Spring Break – No Class			
9	23	xxx	x	Sec 11.8-11.10		Interactive Recording 2 on Two Parameter Margules	VLE: Van Laar 1
	24	xxx	x			PL 24 Quiz	VLE: Van Laar 2
	25	xxx	x	Sec 12.0-12.3	Test 2 Group	PL 25 Quiz	Test 2
10	26	xxx	x	Sec 12.4	Test 2 Individual	No Quiz	Test 2
	27	xxx	x		HW 7	No Quiz	VLE: Wilson 1
	28	xxx	x	Sec 13.0-13.2		PL 28 Quiz	VLE: Wilson 2
11	29	xxx	x	Sec 13.3-13.5		PL 29 Quiz	VLE: Wilson 3
	30	xxx	x		HW 8	PL 30 Quiz	LLE: hand attempt
	31	xxx	x	Sec 14.0-14.9		PL 31 Quiz	SLE: derivation
12	32	xxx	x	Sec 14.10-14.11		PL 32 Quiz	SLE: Ideal
	33	xxx	x		HW 9	PL 33 Quiz	SLE: Wrap Up
	34	xxx	x	Sec 15.0-15.2		No Quiz	Why ChEE $$$
13	35	xxx	x	Sec 15.3-15.6		No Quiz	Keq mole balances
	36	xxx	x			No Quiz	Keq at 298
	37	xxx	x	Sec 17.0-17.5		PL 37 Quiz	Keq details
14	38	xxx	x	Sec 17.6-17.9	Test 3 Group	PL 38 Quiz	Test 3
	39	xxx	x		Test 3 Individual	No Quiz	Test 3
	40	xxx	x	Sec 17.10-17.14		No Quiz	Keq as f(T)

15	41	xxx	x	Sec 17.15-17.20		PL 41 Quiz	
	42	xxx	x		Project Part 1	PL 42 Quiz	
	43	xxx	x			No Quiz	Project
16	44	xxx	x	Review for Final		No Quiz	Project
	45	xxx	x	Review for Final		No Quiz	Project

Project part 2 will due at the start of the final exam. All homework is due on the days listed above unless otherwise designated on a specific problem handout.