CHEMICAL ENGINEERING 312 (3)
Chemical Engineering Thermodynamics
Winter 2020
http://classes.engr.oregonstate.edu/cbee/winter2020/che312/

Instructors:	Professor Milo Koretsky		201 Gleeson milo.koretsky@oregonstate.edu
Teaching Assistants:	Fuqiong Lei		leifu@oregonstate.edu
	Marjan Khorshidi Zadeh		khorshim@oregonstate.edu
	Casey Kanalos		kanalosc@oregonstate.edu
Learning Assistants:	Joe Johnson		
	Shayne Sensenbach		
	Jacob Young		
Class Times:	Lecture:	MWF 10:00-10:50	Wiegand 115
	Studio:	R 1:00, 2:00, 3:00, or 4:00	102, 103 BXL
	You must attend the studio for which you are registered		
Prerequisites:	ChE 311 or equivalent		
Help Hours:	Milo Koretsky:	T 4-6	306 Gleeson
	Fuqiong Lei:	W 2-4	306 Gleeson
	Marjan Khorshidi Zadeh	T 4-6	306 Gleeson
	Casey Kanalos	W 2-4	306 Gleeson
	LAs	TBD	

You can also schedule an appointment with the instructors or GTAs via email; please list at least three available times in your email.

Student Learning Outcomes:

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

1. Pure species phase equilibrium
    a. Describe the role of Gibbs energy in determining pure species phase equilibrium
    b. Apply the Clapeyron equation to relate T and P between two states of a pure species in phase equilibrium.
    c. State when you can simplify the Clapeyron equation to the Clausius-Clapeyron equation.
    d. Apply the first law to systems which undergo a phase change.
2. Thermodynamics of mixtures
    a. Apply thermodynamics to mixtures by defining and finding values for pure species properties, total solution properties, partial molar properties, and property changes of mixing.
    b. Explain enthalpy and entropy of mixing in physical terms
3. Fugacity
    a. Explain how fugacity relates to partial molar Gibbs energy (chemical potential) and why we use it.
    b. Define fugacity. Explain the role of the reference state.

4. Fugacity in the vapor phase:
    a. Calculate fugacity and fugacity coefficient for a pure species i using tables, EOS, and generalized correlations.
    b. Identify appropriate data and reference state
    c. Calculate fugacity and fugacity coefficient for a species i in a mixture using EOS
    d. Describe the Lewis and ideal gas approximations for fugacity of i in a mixture.
    e. Provide physical explanations for the fugacity coefficient.
5. Fugacity in the liquid phase
    a. Explain why we choose the ideal solution as a reference state for a liquid.
    b. Explain the molecular origin and calculate reference fugacities based on the Lewis/Randall and Henry's reference states.
    c. Identify the "shift" in curves of $\ln(\gamma_i)$
    d. Identify when like or unlike interactions are stronger. Know when the Lewis/Randall reference state equals the saturation pressure and how to correct when it does not.
    e. Define g^E and explain why we use it. Determine an expression for and calculate γ_i given a model for g^E
6. Phase equilibrium
    a. Solve phase equilibria problems for Vapor-Liquid equilibria (VLE) and Liquid-Liquid equilibria (LLE).
    b. Identify and solve problems for systems containing azeotropes (VLE) and partially miscible solutions (LLE). Explain what causes each.
    c. Describe how phase diagrams are constructed. Determine phase behavior and composition from phase diagrams.
7. Chemical Reaction Equilibrium
    a. Distinguish between rate and equilibrium in a chemically reacting system.
    b. Use thermochemical data to determine the equilibrium composition for a chemical reaction. Calculate the equilibrium constant at different temperatures.
    c. Determine the equilibrium composition for a system with a single reaction or multiple chemical reactions in a single phase or for heterogeneous reactions.

Textbook:

Engineering and Chemical Thermodynamics, Milo D. Koretsky. John Wiley & Sons (2012). ISBN 0471385867. Chapters 6-9.

Course Grades:

The grades will be based upon examination of course work. The breakdown is as follows:

Concept Warehouse in class	5% + 5% bonus
Studio	10%
Pre-Lecture Quizzes	5%
Homework	10%
Exams (20% Each)	40%
Final Exam	30%

A modified, standard grading scale will be used:

90 - 100	A, A^-
77.5 – 90	B^+, B, B^-
65 – 77.5	C^+, C
Below 65	Not passing

Concept Warehouse (5% + 5% bonus)

We will be doing graded interactive activities regularly in class using the AIChE Concept Warehouse: http://jimi.cbee.oregonstate.edu/concept_warehouse/. You need to bring a device (laptop, tablet, smartphone) to every lecture. While all students are required to have a laptop as part of the College of Engineering's wireless laptop initiative: http://engineering.oregonstate.edu/content/laptop-requirements a smart phone, or tablet will also work with the AIChE Concept Warehouse, as long as it has internet connectivity and a web browser.

Studio (10%) Studios will review lecture materials in an "active learning" environment, supporting the content and context of the previous lectures. In each studio, students will complete an assignment which may include solving problems in class, discussing concepts with peers, or running a simulation. You need to bring a wireless laptop and your textbook to class every studio, unless the instructor announces that you do not have to. Completed assignments will be turned in to the GTA at the end of each studio period. Students will be graded primarily on participation in the assigned activities. Each studio will have a part to be handed in at the end of studio and a part to be turned in for homework. You cannot leave early unless both parts are completed. The studio grade will account for 10% of the overall course grade.

Pre-Lecture Quizzes (5%) To prepare for lecture, there will be a short pre-lecture quiz on posted reading or other material. These will typically be available on the Concept Warehouse.

Homework (10%):

Homework will be available on the web and due each week on Thursday. Homework grading will be managed via the software program Gradescope. You should have received an invitation to Gradescope by Monday, week 1. Homework assignments should be scanned and uploaded to Gradescope by 1 pm on Thursday of the due date. Please plan to give yourself proper time to get your homework scanned and submitted. Bring the hard copy of your homework with you to studio. Any late homework will receive a grade of 0 unless arrangements are made with the instructor before it is due. Failure to turn in 2 homework assignments or more will result in a grade of F in the class.

The way you approach homework has the largest influence on exam performance of anything you do in this class. It is instrumental in helping you grasp fundamental thermodynamic concepts and in exposing you to techniques and skills for applying these principles to new situations. Homework should be done in several sittings; you cannot expect to be successful doing homework quickly the night before it is due. To encourage sense-making and original homework solutions, we will use a ***threshold HW policy***. **If in the opinion of the Instructional Team, you have made a consistent effort on every HW during the term, you will receive 100% score for your HW grade.**

You may discuss homework problems with your classmates (NOT COPY THEIR SOLUTIONS), but you need to try them on your own first. Additionally solutions must be written up independently. ***Unless otherwise stated by the instructor, you are not allowed to look at any solutions of the assigned problems worked by others (e.g., from previous years, the Web, solutions manual, your classmates etc.), before the homework due date - even to check your work. Using worked solutions will be is considered as academic***

dishonesty and may result in an F grade in the class. Assisting others to do this is also considered as academically dishonest.

Use the following guidelines for homework preparation:

- Use clean, 8.5 x 11 inch paper. Engineering paper is preferred; neatness is important and appreciated.
- Write the following in the upper right corner of the first page:
  ChE 312
  Studio time, room and GTA (e.g. R 1300, 103 BXL, Ryan)
  Your Name
  Due date, Problem Set No.
  Page number/Total pages
- **Show all of your work.** Draw a block around your final answer(s).
- For graphical solutions, be careful and accurate with your work. Label the axes of your graph and include units.
- Provide computer program listings or output, if used, on a separate sheet.

Exams (40%) and Final Exam (30%):

There will be two exams, tentatively scheduled for 1/29 (individual) and 1/30 (group), and 2/26/20 (individual) and 2/27/20 (group) in class. The Final Exam is scheduled for Tuesday, March 17, 2020 9:30 – 11:20 AM. You will be asked to apply the fundamental principles that have been covered in the course to entirely new problems and also to answer conceptual questions (questions that are designed to be conceptually challenging and typically require no computation so that students cannot rely on equations to obtain the answer). For the conceptual questions, you will be assessed on your ability to select the correct answer and provide an evidence-based written justification of the choice.

If you MUST miss an Exam or the Final Exam for an emergency situation, please let Prof. Koretsky know as soon as possible. If you oversleep or skip an exam you will not have an opportunity to make it up. If you have a valid (according to me) time conflict and you let Prof. Koretsky know in advance, there is the possibility of taking an exam at an alternate time.

Class Attendance:

You are expected to attend every class and participate in discussion. Lectures are designed to supplement, not replace, the reading material, and to develop problem-solving skills. If you are not able to make class, notify the instructor before class. Unexcused absences may lower your final course grade. ***Historically, students who attend regularly do 10-20% better on exams***. If you do miss class, it is your responsibility to find out what was covered and any administrative information that was discussed.

Disruptive Behavior

While the University is a place where the free exchange of ideas and concepts allows for debate and disagreement, all classroom behavior and discourse should reflect the values of respect and civility. Behaviors which are disruptive to the learning environment will not be tolerated. As your instructors, we are dedicated to establishing a learning environment that promotes diversity of race, culture, gender, sexual orientation, and physical disability. Anyone noticing discriminatory behavior in this class, or feeling discriminated against

should bring it to the attention of the instructors or other University personnel as appropriate.

Cheating and Student Conduct:

The instructors of this class take the issue of academic honesty very seriously. You are expected to be honest and ethical in your academic work. There is a "zero tolerance" policy in effect for cheating in this class. Any instance in which a student is caught cheating will be handled in strict accordance with the policies outlined at http://oregonstate.edu/studentconduct/offenses-0. In order to provide students with a positive learning environment, OSU has adopted a pledge of civility, which can be found at http://osu.orst.edu/admin/stucon/index.htm.

Academic dishonesty is defined as an intentional act of deception in one of the following areas:

- Cheating- use or attempted use of unauthorized materials, information or study aids
- Fabrication- falsification or invention of any information
- Assisting- helping another commit an act of academic dishonesty
- Tampering- altering or interfering with evaluation instruments and documents
- Plagiarism- representing the words or ideas of another person as one's own

Using solutions worked by others to prepare your HW will be considered as a case of academic dishonesty and may result in an F grade in the class.

When evidence of academic dishonesty comes to the instructor's attention, the instructor will document the incident, permit the accused student to provide an explanation, advise the student of possible penalties, and take action. The instructor may impose any academic penalty up to and including an "F" grade in the course after consulting with his School Head and informing the student of the action taken.

Statement Regarding Students with Disabilities:

Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 541-737-4098.

Religious Holiday Statement:

Oregon State University strives to respect all religious practices. If you have religious holidays that are in conflict with any of the requirements of this class, please see me immediately so that we can make alternative arrangements.

Diversity Statement:

Oregon State University strives to create an affirming climate for all students including underrepresented and marginalized individuals and groups. Diversity encompasses differences in age, color, ethnicity, national origin, gender, physical or mental ability, religion, socioeconomic background, veteran status, sexual orientation, and marginalized

groups. We believe diversity is the synergy, connection, acceptance, and mutual learning fostered by the interaction of different human characteristics.