

Phase Chemical Equilibrium

ECH4123

Class Periods: MWF | period 9 (4:05 PM - 4:55 PM)

Location: ROG 110

Instructor:

Tony Ladd

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[Office Hours: Tuesday 4-6 PM ChE 226/230](#)

Course Description

Application of thermodynamic principles to systems of variable composition including the study of phase and chemical equilibria (3 credits).

Course Pre-Requisites

ECH 3101 Process Thermodynamics, ECH 3203 Fluid and Solid Operations, ECH 3223 Energy Transfer Operations

Course Objectives

Formulate problems involving phase and reaction equilibria as minimizations of the Gibbs free energy

Relate thermodynamic properties of mixtures to properties of pure components using activity coefficients

Calculate composition diagrams for VLE, LLE, and VLLE

Calculate equilibrium compositions of reactive species (primarily gases)

Solve equations for phase and reaction equilibria using numerical methods.

Materials and Supply Fees

N/A

Relation to Program Outcomes (ABET):

Outcome	Coverage
1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.	High
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.	
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	
4. An ability to communicate effectively with a range of audiences	
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	
6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge	Medium

appropriately.	
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty	Medium

Coverage is given as high, medium, or low. An empty box indicates that this outcome is not part of the course.

Required Textbooks and Software *Essential Thermodynamics*, by A.Z. Panagiotopoulos, Drios, 2011. (UF library: SCIENCE LIBRARY QD504 .S25 2006). Useful software and a list of typographical errors are posted on the web at <http://driospress.com/et>

Additional Materials

Chemical, Biochemical, and Engineering Thermodynamics by S. I. Sandler (any edition)

Course Schedule (approximate)

Week	Week begins	Topic	Resources
1	8/24	Introduction and Review	AZP: 5.1, 5.2, 5.5 HW1
2	8/31	Equilibrium and stability	AZP: 6.1, 6.2 HW2
3	9/7	Phase Equilibrium	AZP: 6.3 – 6.5 HW3 Quiz 1
4	9/14	EOS, chemical potential, and fugacity	AZP: 7.3, 7.4 HW4
5	9/21	Mixing functions	AZP: 8.1 HW5 Module 1 test (Wk 1 - 4)
6	9/28	Ideal mixtures and VLE	AZP: 8.6, 9.1 (Ex 9.1) HW6
7	10/5	Colligative properties	AZP: 9.5, 9.6 HW7 Quiz 2
8	10/12	Mixture thermodynamics	AZP: 8.2-8.4 HW8
9	10/19	Excess properties and activity	AZP: 8.7, 8.8 Module 2 test (Wk 5 -7)
10	10/26	Liquid-liquid equilibrium	AZP: 9.2 HW9
11	11/2	VLE for non-ideal mixtures	AZP: 9.1, 9.3 HW10 Quiz 3
12	11/9	Chemical equilibria	AZP: 10.2
13	11/16	Standard states and use of tables	AZP: 10.3 HW11 Module 3 test (Wk 8 -11)
14	11/28	Example problems	AZP: 10.4, 10.5 Quiz 4

Policies for Assignments, Make-Ups, and Privacy

- a Students will be assigned homework on Wednesday, which should be completed by Wednesday of the following week. The deadline for homework submissions is 10pm. Late homework will be penalized at 10% per day – starting at 10:01 pm. **Students can have up to 3 one-day extensions over the course of the semester, where homework can be submitted without penalty.** The extensions are granted automatically – no need to contact the instructor.
- b Homework more than 2 days late (i.e. after Friday at 10pm) will not be graded.**
- c Homework assignments will be posted at least 1 week ahead of the due date. They are designed to supplement and reinforce the lectures from the same week (typically W, F, M). Students are strongly encouraged to work on assignments during the week, making use of office hours as needed. You may choose to wait until the last minute to look at the homework, but any adverse consequences, such as late or inadequate submissions, are then your responsibility.
- d Homework submissions must be on Canvas as a scanned pdf or some other common format.
- e Collaboration on homework is encouraged, but the submitted solutions must be your own work. Copying homework solutions from any source is an academic honesty violation for all parties involved.
- f Partial solutions to some homework problems will be posted with the assignment. These are designed to enable students to self check their work. If you have problems getting the correct solution you need to ask questions or come to office hours. Complete solutions will not be provided in general.
- g Assigned reading and videos will be included in each weeks homework (wk*.pdf). Students are expected to be familiar with these materials, as well as material from lectures and homework.
- h Students can also access the notes I prepare (see Files/Notes on Canvas). They will usually be posted over the weekend and cover the previous week's classes.
- i The homework assignments are listed in the table above with the material they will relate to – the week's lectures are scheduled for WFM this semester. Homework's will cover material up to Monday's class and will be due on Wednesday. Office hours are on Tuesday (4-6pm) if you need help.
- j Module tests are scheduled in the Assignments section on Canvas. They will be held during class.
- k The final is cumulative and will be held in the classroom during the time listed in the course schedule.
- l All tests are open book and open notes. You may not access internet web sites during these tests.
- m Homework and tests may require the use of Python to compute solutions to numerical problems. Students may bring programs to these tests as well as notes and books.
- n There will be 4 quizzes during the semester. These are short (10-15 min) closed book, in class tests.
- o You are responsible for all announcements made in class and on Canvas
- p Requests for re-grading of assignments and exams will only be considered within a one-week period from the time graded work is returned.
- q Grades for individual assignments and tests will be posted on the web throughout the semester. You should ensure that they are entered correctly. Corrections will be considered only within a two-week period after the grades have been posted on the web.
- r Students may request a makeup for any activity sponsored by the university, for health reasons, and for family emergencies. Other reasons at the instructor's discretion, but will typically not be allowed. Makeup tests and quizzes will be given at the end of the semester. There will be no make up for the final exam except for health or family reasons. In such cases the student will receive an Incomplete grade, with a makeup to be given the following semester. Request for a make up of any assignment must be made at least 1 week in advance of the assignment (emergency health issues aside).

Evaluation of Grades

Assignment	Percentage of Final Grade
Module 1 test	15%
Module 2 test	15%
Module 3 test	15%
Final exam	25%
Quizzes (4)	5%
Graded Homework (11)	25%
Total	100%

Grading Policy (approximate – subject to modification)

Percent	Grade	Grade Points
>88	A	4.00
84-88	A-	3.67
80-84	B+	3.33
75-80	B	3.00
70-75	B-	2.67
65-70	C+	2.33
60-65	C	2.00
55-60	C-	1.67
50-55	D+	1.33
45-50	D	1.00
40-45	D-	0.67
0 - 40	E	0.00

Schedule of Homework, Quizzes, Tests

Homework	Electronic submission – see Canvas pages for due dates and times
Quizzes	Paper submission – see Canvas pages for dates and time (in class)
Module tests	Electronic submission – see Canvas pages for dates and times (in class)
Final	Electronic submission – see https://one.ufl.edu/soc for date and time

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Conduct Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus:

<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.

Computing support: <https://helpdesk.ufl.edu/>