

## Phase Chemical Equilibrium

ECH4123

**Class Periods:** MWF | period 9 (3:00 PM - 3:50 PM)

**Location:** F2F: CHE 0237 Zoom: 980S Spring 2022

### **Instructor:**

Tony Ladd

[Email Address: tladd@che.ufl.edu](mailto:tladd@che.ufl.edu)

[Office Hours: T/Th 4-5 PM](#) Zoom: 972 2874 1893 Password: Phase

### **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):**

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 appropriately.	Medium

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	1/5	Introduction and Review	Textbook: 5.1, 5.2, 5.5
2	1/12	Equilibrium and stability	Textbook: 6.1, 6.2
3	1/19	Phase Equilibrium	Textbook: 6.3 – 6.5
4	1/26	Using experimental data - fugacity	Textbook: 7.3, 7.4
5	2/2	Mixing functions: example (8.1)	Textbook: 8.1
6	2/7	Partial molar properties Using experimental data: example (8.5) Ideal gas mixtures and fugacity	Textbook: 8.2, 8.4, 8.5
7	2/16	Ideal mixtures, Excess free energy, and activity coefficients	Submit HW6
8	2/23	Activity models Henry's law VLE for ideal mixtures	Textbook: 9.1
9	3/2	VLE for non-ideal mixtures	Textbook: 9.2
10	3/16	LLE & VLLE	Textbook: 9.2, 9.3
11	3/23	Chemical reactions	Textbook: 10.1, 10.2
12	3/30	Standard states and use of tables	
13	3/30	Examples of homogeneous reactions	Textbook: 10.3, 10.4
14	4/13	Heterogeneous and multiple reactions	Textbook: 10.5 & 10.6

#### **Policies for Assignments, Make-Ups, and Privacy**

- Students will be assigned homework from the textbook each Friday, which should be completed by Friday of the following week.
- Homework submissions must be on Canvas as a scanned pdf or some other common format (docx, xlsx, py, etc).
- Collaboration on homework is encouraged, but make sure you are properly distanced from one another. Zoom may be the best option. The submitted solutions must be your own work – copying homework solutions from any source is an academic honesty violation for all parties involved.

- d Short solutions to homework problems will be posted with the assignment. These are designed to enable students to self check most of their work. If you have problems getting the correct solution you need to ask questions. Complete solutions will not be provided in general.
- e Assigned reading and sometimes videos will be included in each weeks homework (wk\*.pdf). Students are expected to be familiar with these materials, as well as from lectures and homework.
- f Students can also access the notes I prepared last year (see Files/Notes on Canvas). If I make substantial changes I will post updates.
- g Module tests are scheduled in the Assignments section on Canvas.
- h Module tests are open book and open notes. You may not access internet web sites during these tests. They will be on the scheduled days at times to be determined.
- i Homework and Module tests will require the use of Python to compute solutions to numerical problems. Students may bring programs to these tests as well as notes and books.
- j You are responsible for all announcements made in class and on Canvas
- k Requests for re-grading of assignments and exams will only be considered within a one-week period from the time graded work is returned.
- l 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.
- m 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).
- n Our class sessions and office hours may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared.

### ***Evaluation of Grades***

<b>Assignment</b>	<b>Percentage of Final Grade</b>
Module tests (4)	70%
Graded Homework (12/13)	30%
Total	100%

### ***Grading Policy (approximate – subject to modification)***

<b>Percent</b>	<b>Grade</b>	<b>Grade Points</b>
85-100	A	4.00
80-85	A-	3.67
75-80	B+	3.33
70-75	B	3.00
65-70	B-	2.67
60-65	C+	2.33
55-60	C	2.00
50-55	C-	1.67
45-50	D+	1.33
40-45	D	1.00

35-40	D-	0.67
0 - 35	E	0.00

### **Schedule of Homework, Quizzes, Tests**

Homework	Electronic submission – see Canvas pages for dues dates and times
Module tests	See Canvas pages for dates and times

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](mailto:jpennacc@ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto: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](mailto: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](mailto: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/>.

##### **COVID-19**

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email [covid@shcc.ufl.edu](mailto:covid@shcc.ufl.edu)) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

### Academic Resources

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to [Learning-support@ufl.edu](mailto: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/>