

Phase and Chemical Equilibria

ECH 4123 Section 11795

Class Periods: MWF | Period 9 (4:05 PM – 4:55 PM)

Location: CSE E220

Academic Term: Fall 2024

Instructor:

Kirk Ziegler

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421 ChE

Office Hours: Tue/Thu 11 – 12:30

Course Description

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

Course Pre-Requisites / Co-Requisites

All students should have successfully passed Process Thermodynamics (ECH 3101), Fluid and Solid Operations (ECH 3203), and Energy Transfer Operations (ECH 3223) prior to enrollment.

Course Objectives

Upon completion the student should be able to:

- 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

None

Relation to Program Outcomes (ABET):

The contribution of the course to meeting the professional components of the ABET-accredited degree is:

| Outcome | Coverage* |
|---|-----------|
| 1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics | High |
| 2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors | |
| 3. An ability to communicate effectively with a range of audiences | |
| 4. 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 | |
| 5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives | |
| 6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions | Medium |
| 7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies | Medium |

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

- Title: Chemical, Biochemical, and Engineering Thermodynamics
Author: Stanley I. Sandler
Publication date and edition: 2017 and 5th edition
ISBN number: 978-1-119-32128-6

NOTE: There are some additional sections, which are available at the E-learning site.

- Kritik is a software program available at kritik.io. Kritik is a peer assessment tool that will be used for completing homework assignments and assessing the work of other students.

Recommended Materials

- Chemical and Process Thermodynamics, B. G. Kyle, Prentice Hall
- Introductory Chemical Engineering Thermodynamics, J.R. Elliott and C.T. Lira, Prentice Hall, Englewood Cliffs, New Jersey
- Introduction to Chemical Engineering Thermodynamics, J. M. Smith and H. C. Van Ness, McGraw-Hill

Required Computer

UF computing requirement: <https://news.it.ufl.edu/education/student-computing-requirements-for-uf/>

Tentative Course Schedule

| | Week | Lectures | Reading assignments |
|------------------|-------------|---|---------------------|
| First Exam | 1 | Introduction and Review | Chapters 1 - 6 |
| | 2 | Equilibrium States and Phase Equilibrium | Sections 7.1-7.3 |
| | 3 | Fugacity of Pure Components | Sections 7.4-7.6 |
| | 4 | Thermodynamic Properties of Phase Transitions | Sections 7.7-7.8 |
| Tentative | 9/26 | EXAM (evening TBD) | |

| | Week | Lectures | Reading assignments |
|------------------|-------------|--------------------------------------|---------------------|
| Second Exam | 5 | Partial Molar Properties | Sections 8.1 |
| | 6 | Gibbs Duhem Relations | Sections 8.2-8.4 |
| | 7 | Calculating Partial Molar Properties | Sections 8.5-8.8 |
| | 8 | Fugacity of Mixtures | Sections 9.1-9.2 |
| | 9 | Activity Coefficients | Sections 9.1-9.11 |
| | 10 | Vapor-Liquid Equilibrium | Sections 10.1-10.3 |
| | 11 | Other Equilibria | Sections 11.1-11.3 |
| Tentative | 11/7 | EXAM (evening TBD) | |

| | Week | Lectures | Reading assignments |
|------------|--------------|------------------------------|---------------------|
| Third Exam | 12 | Chemical Equilibria | Sections 13.1-13.2 |
| | 13 | Chemical Reactors | Sections 14.1-14.3 |
| | 14 | Electrochemical Systems | Sections 13.5; 14.6 |
| | 15 | N/A | |
| | 12/11 | EXAM (5:30 = 7:30 PM) | |

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance of all lectures is highly recommended. It is the student's responsibility to obtain any notes, assignments, etc. that they may have missed during their absence. Repeated absences may lead to a lower grade in the class. Excused absences must be consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>) and require appropriate documentation.

As a courtesy to the other students and to the instructor, the students should turn off the ringers for all cell phones during class and they should not answer incoming calls. If a student is expecting an emergency call, please notify the instructor prior to class.

Students who do not attend an exam at the scheduled time will receive a score of zero for that exam. Exceptions will be made only in extraordinary circumstances, such as religious holidays or emergencies. It is required that, whenever possible, the student notifies the instructor about the situation prior to the exam, preferably at least two weeks in advance.

Evaluation of Grades

| Assignment | Percentage of Final Grade |
|-------------------|----------------------------------|
| Homework | 10% |
| Quizzes | 15% |
| Exam 1 | 25% |
| Exam 2 | 25% |
| Exam 3 | 25% |
| | 100% |

Homework: Homework will be assigned throughout the semester. The homework solutions will be posted on the class website after the assignment due date but before any quizzes on the material. Students will submit their assignments through Kritik on the E-learning website. To receive full credit for the assignment, students will need to create the assignment, evaluate the work of other students, and submit feedback. For each assignment, the instructor will select a subset of problems assigned for evaluation.

Quizzes: Quizzes will be assigned throughout the semester. The material on quizzes will cover problems closely related to the previous homework assignment. No make-up quizzes will be given. Excused absences will not count against the final grade. Each quiz is equally weighted. All quizzes will be approximately 15 – 20 min and be closed book and closed notes.

Exams: Each exam will be open book and open notes. No credit will be given for problems that have a solution but all the work leading to this solution is not shown.

Grading Policy

| Percent | Grade | Grade Points |
|----------------|--------------|---------------------|
| 93.4 - 100 | A | 4.00 |
| 90.0 - 93.3 | A- | 3.67 |
| 86.7 - 89.9 | B+ | 3.33 |
| 83.4 - 86.6 | B | 3.00 |
| 80.0 - 83.3 | B- | 2.67 |
| 76.7 - 79.9 | C+ | 2.33 |
| 73.4 - 76.6 | C | 2.00 |
| 70.0 - 73.3 | C- | 1.67 |
| 66.7 - 69.9 | D+ | 1.33 |
| 63.4 - 66.6 | D | 1.00 |
| 60.0 - 63.3 | D- | 0.67 |
| 0 - 59.9 | E | 0.00 |

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 Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

A non-passing letter grade will be assigned to students who violate academic honesty standards, regardless of the violator's performance on exams, quizzes, and homework assignments. Official sanctions issued by the Office of Student Judicial Affairs will become permanently noted in the student's official transcript.

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 Undergraduate Program Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@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:

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://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

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