

PHASE AND CHEMICAL EQUILIBRIA

ECH4123 | Section 0L07

Class Periods: M, W, F | Period 7 (4:05 AM - 4:55 PM)

Location: Online delivery via Zoom

Academic Term: Spring 2021

Instructor

Dr. Oscar D. Crisalle

Professor and Distinguished Teaching Scholar

University of Florida, Chemical Engineering Department

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Office Hours: TBA, Open-door policy. Students can also make an appointment.

Supervised-Teaching Student

None

Office hours: Not applicable

Grader

Not applicable

Course Description

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

Course Pre-Requisites

ECH3101 (Process Thermodynamics), ECH3202 (Fluid and Solid Operations) and ECH3223 (Energy Transfer Operations)

Course Objectives

Upon completion of this course the student will be able to:

1. Demonstrate knowledge of the thermodynamics equations that dictate behavior of phase and chemical equilibria.
2. Evaluate chemical potentials and fugacities in pure components and mixture systems.
3. Demonstrate ability to apply thermodynamics phase and chemical equilibrium theory to liquid-liquid, vapor-liquid, and solid-liquid systems.
4. Demonstrate ability to use software tools to evaluate thermodynamic properties of pure component and mixture systems.

Materials and Supply Fees

Not applicable

Professional Component (ABET)

The ABET *Student Outcomes* (SO) assessed in this course are:

1. **SO 1:** An ability to identify, formulate, and solve complex problems by applying principles of engineering, science, and mathematics. (Coverage: HIGH)
2. **SO 7:** An ability to acquire and apply new knowledge as needed, using appropriate learning strategies (Coverage: HIGH)

Required Textbook

Stanley I. Sandler, *Chemical, Biochemical, and Engineering Thermodynamics*, 5th Edition, Wiley, 2006.

Recommended Textbook

Dahm, Kevin D., and Donald P. Visco, *Fundamentals of Chemical Engineering Thermodynamics*, Nelson Education, 2014.

Recommended Software

At the discretion of the instructor, this class will utilize the MATLAB and Simulink packages of TheMathworks. This software is available free of charge for students at any of the UFIT Computer Labs located on campus (<https://labs.at.ufl.edu/>). Students can also use the browser-based version of the software offered through UFApps (<https://info.apps.ufl.edu/>). A *Student Edition* or MATLAB, including Simulink is available at a discounted student price (consult the UF Bookstore).

Course Topics

1. INTRODUCTION
 - 1.1 Review of first and second laws of thermodynamics
 - 1.2 Physical properties of materials
 - 1.2.1 Pure substances
 - 1.2.2 Mixtures
 - 1.3 Thermodynamic equilibrium and stability
 - 1.3.1 Pure substances
 - 1.3.2 Mixtures
 - 1.4 Applications of thermodynamic equilibrium and stability criteria
 - 1.4.1 Applications to the equation of state
 - 1.4.2 Computation of vapor pressure from an equation of state
 - 1.4.3 Gibbs phase rule for one-component systems
 - 1.4.4 Properties of phase transitions
 - 1.5 Models used to describe thermodynamic equilibria
 - 1.5.1 The partial molar Gibbs free energy and fugacity
 - 1.5.2 Fugacity of a species in a gas, liquid, or solid mixture
 - 1.5.3 Fugacity of a species in a nonsimple mixture

2. EVALUATION OF CHEMICAL POTENTIAL AND FUGACITIES
 - 2.1 Gas mixtures
 - 2.2 Condensed mixtures
 - 2.3 Activity coefficient models for gas and condensed mixtures
 - 2.4 Group contributions in condensed mixtures

3. APPLICATIONS
 - 3.1 Vapor-liquid equilibrium
 - 3.2 Liquid-liquid equilibrium
 - 3.3 Solid-liquid equilibrium
 - 3.4 Colligative properties
 - 3.5 Electrolyte solutions

- 3.6 Reacting systems: single-phase and heterogeneous case

The list of covered topics may be changed at the sole discretion of the instructor as needed to better serve the learning needs of the class.

Online Course Recording

At the discretion of the instructor, class sessions 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, you must contact the instructor to discuss options. If your objection stands, 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 must consult the instructor to discuss options. If your decision stands, 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. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Attendance Policy, Class Expectations, and Make-Up Policy

Class attendance is required in this class. Excused absences are consistent with university policies stated in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation. Requests for make-up tests will be granted only if appropriate documentation about illness, family emergency, job interview, or UF-related travel are provided and verified by the Instructor.

Evaluation of Grades

Assignment	Total Points ¹	Percentage of Final Grade
Homework	100 ²	15 %
Quizzes	100 ²	15 %
Projects	100 ³	15 %

Midterm 1	100	15 %
Midterm 2	100	15 %
Final Exam	100	25 %
		100%

- ¹ The total number of points earned through this component will be normalized to 100.
- 2 It is expected that each student will have the total score larger than 50 % for all homework assignments during the semester. Similarly, the total score larger than 50 % is expected for all quizzes during the semester. A failing grade will be assigned to students if the total score for all homework assignments or for the quizzes is smaller than 50%.
- 3 A total score higher than 50 % is expected in the Projects category. A failing grade will be assigned if the total score is less than 50 % or for failure to submit an acceptable project report.

Grading Policy

The following is given as an example only. The instructor reserves the right to modify the policy based on his sole discretion to better assess the performance of the class.

Percentage	Score	Letter Grade	Grade Points
91.84 -	100.00	A	4.00
89.04 -	91.83	A-	3.67
86.24 -	89.03	B+	3.33
83.44 -	86.23	B	3.00
80.64 -	83.43	B-	2.67
77.84 -	80.63	C+	2.33
75.04 -	77.83	C	2.00
72.24 -	75.03	C-	1.67
69.44 -	72.23	D+	1.33
66.64 -	69.43	D	1.00
61.04 -	66.63	D-	0.67
0.00 -	61.03	E	0.00

The Percentage-Score ranges shown above are calculated using an assumed class mean Percentage score of 80 % and a standard deviation of 10 %. The ranges may change as a function of the final statistics values at the end of the course. More information on the UF grading policy may be found at:

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

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when

requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

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.

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
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.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

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:

If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

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

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://www.crc.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>.

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