

Material & Energy Balances

ECH 3023 Section 0674

Class Periods: MWRF Period 5, 11:45 AM - 12:35 PM

Location: MWF: [FLG 0220](#) ; R: [WM 0100](#)

Academic Term: Fall 2022

Instructor:

Prof. Richard B. Dickinson

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352-235-4494

Office Hours: Monday 2-3 pm; Thursday 2-3 pm; 493 Wertheim Lab or by Zoom (ID 911 435 1653)

Peer Mentor:

Please contact through the Canvas website

- TBD

Course Description

Formulation and solution of material and energy balances utilizing physical/chemical properties of matter as applied to analyzing unit operations systems.

Course Pre-Requisites / Co-Requisites

Pre-requisites: CHM 2046, MAC 2312 and PHY 2048; Co-requisites: PHY 2049 and MAC 2313

Course Objectives

Upon completion of this course, a student should be able to:

- Describe the range of functions that chemical engineers perform as well as the impact of engineering solutions in a global and societal context
- Identify the unit operations involved in a process, draw process flowcharts for single- and multiple-unit operations, identify process variables, label process streams, and develop relationships between process variables for individual process units and complex processes common to chemical engineering practice.
- Develop mass and energy balances equations necessary to solve reaction and non-reaction steady-state and transient systems.
- Perform simple degree-of-freedom analysis to identify the number of unknowns relating total mass and energy, mass and energy flow rates, and mass composition.
- Understand fundamental relationships (equations of state, phase equilibria, vapor pressure) and empirical relationships (Raoult's law, Henry's laws, Antoine equation) for phase equilibrium and apply these to the solutions of mass and energy balance problems.
- Use tables, charts, or software to estimate physical property data need to solve material and energy balances.
- Report engineering calculations and problem solutions in a professional manner.
- Work together in a team to accomplish an engineering goal.

Materials and Supply Fees

N/A

Required Textbook:

Elementary Principles of Chemical Processes (4th Ed.) by Felder, Rousseau, and Bullard; Wiley, ISBN 13:978-0-470-61629-1

Required Software:

Microsoft Excel will be needed for some homework assignments and in-class exercises. Therefore, you will need access to this software on your personal laptop. Students will need to scan and upload documents to CANVAS.

Course Schedule

Wk	Day	Date	Topic	Reading	HW Due
1	W Th F	Aug 24 25 26	1 - Course Overview 2 - Engineering calculations Review & Quiz 1	1 2.0-6	
2	M W Th F	29 31 Sep 1 2	3 - Data Representation & Analysis 4 - Process variables 5- Process variables / Balance Equations Review & Quiz 2	2.7-8 3.0-2 3.1-6, 4.0-2	HW 1
3	M W Th F	5 7 8 9	HOLIDAY (Labor Day) 6 - Material Balances 7 - Material Balances Exam 1	4.3-4	HW 2
4	M W Th F	12 14 15 16	8 - Multi-unit processes 9 - Recycle & bypass 10 - Reactive systems Review & Quiz 3	4.5 4.6	
5	M W Th F	19 21 22 23	11 - Reactive systems 12 - Combustive systems 13 - Atomic species balances Review & Quiz 4	4.7 4.8-10	HW 3
6	M W Th F	26 28 29 30	14 - Density, Ideal Gas 15 - Non-ideal gases 16 - Single-Component Phase Equil. Exam 2	5.0-2 5.3-5 6.0-2	HW 4
7	M W Th F	Oct 3 5 6 7	17 - Gas-liquid equilibrium 18 - Multi-component Vapor-liquid Equil. Review & Quiz 5 HOLIDAY (Homecoming)	6.3 6.4	
8	M W Th F	10 12 13 15	19- Multi-component Vapor-liquid Equil 20 - Multi-component Vapor-liquid Equil. 21 - Liquid-liquid, solid-liquid equil. Review & Quiz 6	6.5	HW 5
9	M W Th F	17 19 20 21	22 - Energy balances 23 - Energy balances 24 - Energy balances Exam 3	7.1-3 7.4-6	HW 6
10	M W Th F	24 26 27 28	25 - Thermodynamic properties 26 - Energy balance calculations 27 - Phase change operations Review & Quiz 7	7.7 8. 1-3 8.4	
11	M W Th F	31 Nov 2 3 4	28- Mixing and solution problems 29 - Energy balances problems 30 - Heats of Reaction Review & Quiz 8	8.5-6 9.0-2	
12	M W Th F	7 9 10 11	31 - Heats of formation and combustion 32 - Energy balances -reactive processes Exam 4 HOLIDAY (Veterans Day)	9.3-4 9.5-6	HW 7
13	M W Th F	14 16 17 18	33 - Energy balances -reactive processes 34 - Energy balances -reactive processes 35 - Energy balances -reactive processes Review & Quiz 9		HW 8
14	M W Th F	21 23 24 25	36 - Energy balances -reactive processes HOLIDAY (Thanksgiving) HOLIDAY (Thanksgiving) HOLIDAY (Thanksgiving)		
15	M W Th F	28 30 Dec 1 2	37- Transient processes 38 - Transient processes 39 - Transient processes Review & Quiz 10	10.0-2 10.3-5	HW 9
16	M W W	5 7 27	Review / Team project Review / Team project Exam 5 (12:30-2:30)		HW 10

Attendance Policy, Class Expectations, and Make-Up Policy

While attendance is not monitored, be aware that regular attendance is essential to succeed in this course. Quizzes and exams missed due to unexcused absence (per UF attendance policies linked below) will be counted as zero in the final grade. Make up exams will be provided for excused absences. Make up quizzes are not provided; instead, missed quizzes under excused absence are not included in the quiz average.

<https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets (10)	100 each	12%
Quizzes (10)	100 each	16%
Exams (5)	100	63%
Team Project	100	9%

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>

Homework: Homework (HW) is due every Wednesday except on weeks following exams. HW is submitted via CANVAS in a single PDF document along with accompanying Excel files. Late HW is not accepted. Each HW assignment is equally weighted. HW must be prepared neatly, professionally, and per instructions to receive full credit. Include your name, date, and HW number on the first page. Write only on one side of paper and use a straightedge or template for diagrams. Solutions will be posted on CANVAS. Students are encouraged to help each other on HW, but copying someone else's solution or allowing someone else to copy yours is cheating and a violation of academic honesty policy. Rule of thumb: Discuss the HW and help each other, but don't look at anyone else's work or show them your work.

HW problem scoring (out of maximum five pts): 4 pts: Correct answer showing work. 3 pts: Nearly correct with minor calculation error(s); 2 pts: Significant attempt, but wrong approach; 1 pt: Minimal attempt, or answer without supporting work. +1 point for neatness and professional presentation following the above guidelines. HW problems may be weighted differently when calculating the overall HW assignment score due to variability in effort required.

Exams: Exams scheduled every 3rd Friday of the semester and on the schedule final exam date. The five exams including the final are equally weighted, **except** the exam with the lowest score is given half weight (i.e. the lowest exam is worth only 7% of the final grade, while the other four are worth 14% each).

Quizzes: Quizzes will be given at the end of every non-exam week. The quizzes will generally cover lecture material from the previous few class periods and will require 15-30 minutes to complete. Solutions will be posted on CANVAS.

Project: A group project will be assigned near the middle to the semester and due at the end of the semester. The groups of four or five will be assigned after Exam 2.

Relation to Program Outcomes (ABET):

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	Low
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	Low
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	Medium
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	High

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://sccr.dso.ufl.edu/process/student-conduct-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.

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
- 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>.