

Material and Energy Balances

ECH3023 Class #30032 Section TES1

Class Periods: MWRP Period 9 (4:05-4:55 PM)

Location: FLG 0280

Academic Term: Fall 2024

A quick word of advice

Material and Energy Balances (MEB) is the first class in the curriculum of Chemical Engineering (ChE). This course will introduce you to ideas, concepts, equations, and processes that you will **repeatedly** revisit in finer detail in later ChE courses. Therefore, it is essential that you work hard to master the material, because subsequent courses will build on the foundation established here.

Most concepts in MEB might not seem difficult to understand at face value. However, the difficulty in this class lies in the *application* of these concepts in order to solve problems. While your core science and math courses relied heavily on rote memorization to teach you the mechanics of problem-solving, this course will test your ability to apply information in new situations.

The people that you meet in this class will become your colleagues for the remainder of your ChE education and beyond. I suggest that you meet and interact with as many of your classmates as possible, even if you are introverted. You are encouraged to work and study in groups and help each other as much as possible (in compliance with principles of academic honesty; see below).

Instructor: VJ Tocco

I prefer that you call me "VJ", but you may also call me "Dr. Tocco" if you are more comfortable addressing your instructors formally.

Email Address: vjtocco@ufl.edu

Office: 322 Black Hall, (352) 294-1290

Office Hours: TBD, tentatively Mondays, Wednesdays, and Thursdays from 5:00 PM – 6:00 PM

Teaching Assistant/Peer Mentor/Supervised Teaching Student: None

Course Description

(4 credits) 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

Prerequisites: CHM 2046 (General Chemistry), MAC 2312 (Calculus 2) and PHY 2048 (Physics 1)

Co-requisites: PHY 2049 (Physics 2), MAC 2313 (Calculus 3), MAP 2302 (Differential Eq.), and ECH 4934 (Professional Seminar)

Course Objectives

Broadly, at the end of this course, a student should be able to do the following:

1. Perform basic chemical engineering calculations, including (but not limited to) unit conversions, mass/mole conversions, balance chemical reactions, interpolate tabulated data...
2. Draw and label a process flow diagram from a written description of a process.
3. Perform a degree-of-freedom analysis.
4. Derive and solve the equations needed to solve for unknown process variables.
5. Use Microsoft Excel to automate repeatable and tedious calculations.

In addition to these learning objectives, the assignments are designed to develop the following skills, which are characteristic of real-world problems, and therefore essential for any practicing chemical engineer:

1. Read, interpret, and follow directions, prompts, and problem statements.
2. Detect and disregard superfluous given information.
3. Use resources to find extra information which is needed, but not given.
4. Brainstorm reasons for unexpected behavior (troubleshooting).

Materials and Supply Fees

None

Relation to Program Outcomes (ABET):

Specific outcomes of instruction

- The student will be able to 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.
- The student will be able to develop mass and energy balance equations necessary to solve reactive and non-reactive steady-state and transient systems by hand.
- The student will be able to 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.
- The student will be able to use fundamental thermodynamic relationships (equations of state, phase equilibria, vapor pressure) as well as empirical thermodynamics relationships (Raoult's law, Henry's law, Antoine equation), and apply these to the solution of mass and energy balance problems.
- The student will be able to report engineering calculations and problem solutions in a professional manner.

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

Required Textbook

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

Notes:

- *This textbook is regarded by many practicing Chemical Engineers as one of the most helpful and well-written Chemical Engineering textbooks. Although readings will not be assigned for course credit, you may find that reading the textbook is essential in order to perform well in this course. The textbook also contains many useful tables of physical data. You may use another edition of the textbook, but keep in mind that it is your responsibility (and your responsibility alone!) to determine the differences between your edition and the 4th edition.*
- **You are allowed to use your textbook and notes during exams, but no electronic aids (see below). If you opt for an electronic version of the textbook, be aware that you must print any relevant sections/tables that you want to reference.**

Required Software

Microsoft Excel may be useful for some homework assignments. Therefore, you will need access to this software on your personal laptop.

Aspen HYSYS may also be used for some homework assignments. Instructions for downloading and using this software will be provided. (There is no cost to the student, but you may have to use a VPN to log into the UF network).

Recommended Materials

Any model of scientific calculator may be useful for solving homework and exam problems.

Required Computer

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

Minimum System Requirements:

Operating System: Windows 10 or 11 required.

Processor: Intel Core-i5 family.

Memory: 16GB RAM

Storage: SSD with 120GB of available space.

Monitor: Graphics hardware acceleration requires a DirectX10 graphics card and a 1280 x 1024 or higher resolution monitor.

Network: 100MB/Sec.

Recommended System Requirements:

Operating System: Windows 11.

Processor: Intel Core-i7 family.

Memory: 16GB RAM

Storage: SSD with 250GB of available space.

Monitor: Graphics hardware acceleration requires a DirectX10 graphics card and a 1280 x 1024 or higher resolution monitor.

Network: 100MB/Sec.

Course Schedule

Week	Topic(s)
1	Course Introduction, Chemical Processes, Data Fitting, Pressure
2	Process Variables, Process Classification, Process Flow Diagrams
3	Material balance calculations, Single-Unit Processes, Multiple-Unit Processes
4	Recycle/Bypass, Stoichiometry, Reactive Systems
5	Combustion Reactions
6	Ideal Gas Law, Single-Phase Systems, Introduction to Phase Equilibrium
7	Multiphase Systems, Txy & Pxy Diagrams
8	Introduction to Energy Balances
9	Thermodynamic Data Tables, Mechanical Energy Balances
10	Non-reactive Systems Involving an Energy Balance
11	Nonreactive Energy Balances
12	Reactive Energy Balances
13	Chemical Engineering Ethics and Safety
14/15	Unsteady-State Processes
15/16	Review, Course Debrief, and Outlook

Important Dates

Wednesday, September 11	Quizzam 1 (In class)
Wednesday, September 25	Quizzam 2 (In class)
Wednesday, October 9	Quizzam 3 (In class)
Wednesday, October 23	Quizzam 4 (In class)
Wednesday, November 6	Quizzam 5 (In class)
Wednesday, November 20	Quizzam 6 (In class)
Wednesday, December 11:	Final Exam (5:30 PM – 7:30 PM, In the classroom)

Attendance Policy and Class Expectations

The general format of ECH3023 is “flipped”, meaning that content videos/reading will be assigned prior to each class period. Class time will be dedicated to guided and small-group problem solving and discussion.

You are expected to attend class in-person prepared to participate. Attendance and participation will be indirectly graded as part of your participation grade.

If you are unable to attend class on a non-Quizzam day for any reason, simply e-mail VJ with a brief explanation before class. No further documentation is required.

Make-Up/Absences Policy

If you are unable to take a Quizzam due to illness or other excused absence, please complete an Instructor Notification Request on the Dean of Students website: (<https://care.dso.ufl.edu/instructor-notifications/>). Note that

certain absences are exempt from the Instructor Notification Request, including disability-accommodated absences, UF-sponsored performances, military obligations, and religious observances. In this case, e-mail VJ with documentation directly.

In the case of an excused absence for a Quizzam that cannot be made up the same day, a single comprehensive make-up will be administered at the end of the semester. Make-up work for extended excused absences will be considered on a case-by-case basis in a manner that is fair for you and your classmates.

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies:

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

Evaluation of Grades

Midterm Quiz-Exam Hybrids (6): 15% each (90% of total grade)

“Quizzams” will be held approximately every two weeks in class (time limit 50 minutes; dates listed above). On quizzams, you may reference your textbook and notes, excluding solutions to example problems that you did not produce independently. However, you may not use any electronic aids (i.e. phones, tablets or computers), except a calculator. Consider the Quizzams as cumulative, because material from each section builds upon skills and concepts learned in previous chapters.

Final Exam: Optional; replaces bottom two quizzam grades (30% of total grade possible)

The final exam will be held during finals week (5:30-7:30 PM on 12/11), under the same rules and regulations as the midterm quiz-exam hybrids, except for the length (the final exam is two hours instead of 50 minutes).

The final exam is completely optional. If a student chooses to take it, the final exam grade will replace their two lowest individual quizzam scores.

Team-Based Homework (10% of total grade):

Team-based homework will be assigned approximately bi-weekly. Expect these homework problems to challenge you. VJ will answer direct, well-articulated questions relating to the homework, but will not guide you through the solution, troubleshoot your mistakes, or check your answers before submission.

In completing the homework assignments, you may not seek, possess, use, reference, or look at any work or solution (in part or in whole) that was not developed by you or your team. This includes, but is not limited to, previous students assignments, work developed by classmates, and solutions on online websites (like Chegg or Course Hero). Posting homework problems online and looking at solutions on these websites is a violation of academic honesty.

Solution Submission: Homework is to be submitted electronically on Canvas. A good problem solution primarily consists of a description of problem-solving logic in complete sentences, with equations to supplement the logic. Your work should be organized neatly and be easy to read and follow. You may type your solutions, but equations must be typeset with the “Equation Editor” in Word (or equivalent in another program). Because this can become quite time-consuming, I recommend hand-writing your solutions.

There are several free smartphone apps that can scan your work and convert it to a PDF (such as “CamScanner”). Photographs (learn the difference between a PDF and a photograph) are not acceptable. Please let VJ know if access to this technology is unavailable, and accommodations will be made.

Late homework will be penalized 10% per day, up to *three days* after the due date.

(TENTATIVE) Participation/Self-Directed Learning Project: (6% of final grade, to be taken out of Quizzam portion if enacted)

A self-directed learning project may be assigned into the semester. If enacted, 6% of the “Quizzam” scores will be repurposed for credit on this project and in-class participation.

Your participation during class will be assessed multiple times throughout the semester. Asking questions, engaging during problem-solving sessions, attending office hours, and helping others are all activities that will reflect positively in participation score. Excessive absences, multitasking during class, and not volunteering during class are examples of activities that will reflect negatively in participation score.

Regrades:

To submit a regrade, email VJ. You must directly state the exact number of points you deserve and a full explanation of the discrepancy (unless it is a simple addition error). The entire assignment may be re-graded as a result of a regrade request. **The deadline for regrades is one week from the date the assignment was graded.**

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

Note that departmental policy requires a minimum grade of C to continue to the next courses in the Chemical Engineering curriculum.

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.ua.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.bluer.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 varied perspectives and lived experiences within our community and is committed to supporting the University’s core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

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 Coordinator
- HWCHE 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:

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://elearning.ufl.edu/>.

Career Connections 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: <https://distance.ufl.edu/getting-help/>; <https://distance.ufl.edu/state-authorization-status/#student-complaint>.