

Material and Energy Balances
ECH 3023 Sections 12891
Class Periods: TR; Period 8-9 (3:00-4:55 PM)
Location: FLI 0105 (Tues), AND 0134 (Thurs)
Academic Term: Spring 2020

A quick word of advice:

Material and Energy Balances (MEB) is the first class in the curriculum of Chemical Engineering. 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 this material.

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 old 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:

Prof. Piyush K. Jain

I prefer that you call me "Dr. Jain". You can also call me Prof. Jain if you are more comfortable addressing your instructors formally.

E-Mail: jainp@ufl.edu

E-mail is my preferred method of communication outside of class time. In order to ensure that I reply, you must use proper e-mail etiquette and include "ECH3023" in the subject line.

Office: 329A Chemical Engineering, (352) 294-7012

Office Hours: Wednesday, 6 PM-8 PM

I have an open-door policy; if I am in my office with the door open, you are welcome to come in at any time. However, please do not disturb if the door is closed and you are coming unannounced.

Office hour policy: I intend for office hours to help you with conceptual understanding of course concepts, not to guide you through your homework assignments. I will not check your homework in office hours or otherwise. I will not offer much, if any, assistance with the homework during office hours.

Supervised Teaching Student:

Rachel I Martin

E-mail: martin@ufl.edu

Office: Chemical Engineering Student Center

Office Hour: Mondays, 6-7 PM

Exam Dates

Thursday, February 13th (3:00 - 4:55 PM) AND 0134

Tuesday, March 31st (3:00 - 4:55 PM) FLI 0105

Tuesday, April 28th (12:30 PM - 2:30 PM) FLI 0105

If you have a conflict (another exam) during any of these times, please notify your instructor ASAP.

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), and MAP 2302 (Differential Eq.)

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, interpolations...
- 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

Professional Component (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.

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	
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	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	High

Required Textbooks and Software

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

Note: This textbook will be used primarily as a reference in this course. Reading the textbook is essential in order to perform well in this course, although readings are not required as an assignment. The textbook also contains many useful tables of physical data. You may use another edition of the textbook, but keep in mind that is your responsibility (and your responsibility alone!) to determine the differences between your edition and the 4th edition.

Required Software

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

We will be using the **Top Hat** (www.tophat.com) classroom response system in class. You will be able to submit answers to in-class questions using Apple or Android smartphones and tablets, laptops, or through text message.

You can visit the Top Hat Overview (<https://success.tophat.com/s/article/Student-Top-Hat-Overview-and-Getting-Started-Guide>) within the Top Hat Success Center which outlines how you will register for a Top Hat account, as well as providing a brief overview to get you up and running on the system.

An email invitation will be sent to you by email, but if don't receive this email, you can register by simply visiting our course website: <https://app.tophat.com/e/757041>

Note: our Course Join Code is 757041

Top Hat may require a paid subscription, and a full breakdown of all subscription options available can be found here: www.tophat.com/pricing.

Should you require assistance with Top Hat at any time, due to the fact that they require specific user information to troubleshoot these issues, please contact their Support Team directly by way of email (support@tophat.com), the in app support button, or by calling 1-888-663-5491.

Recommended Materials

A scientific calculator (any model, except those with communication abilities) is recommended for exams. During exams, you may not use your cell phone as a calculator, nor may you share a calculator with a classmate.

Course Tentative Schedule

Week	Begins	Topic(s)	Reading	Due
1	1/7	Course Introduction, Dimensions, Unit Conversions, Process Data, Model Fitting	Ch. 1, 2	
2	1/13	Process variables: Mass/Moles/Volume, Flow Rates, Pressure, Temperature	Ch. 3	HW1
3	1/21	Material balance calculations, Single-Unit Processes, Multiple-Unit Processes	Ch. 4.1-4.3	HW2
4	1/27	Recycle/Bypass, Reaction Stoichiometry	Ch. 4.4-4.5	HW3
5	2/3	Reactive Processes, Combustion Reactions	Ch. 4.6	HW4
6	2/10	Catch-up & Review		Exam 1*
7	2/17	Single-Phase Systems, Equations of State	Ch. 5	HW5
8	2/24	Phase Equilibrium, Gibbs Phase Rule, and Single-Component Equilibrium	Ch. 6.1-6.3	HW6
9	3/9	Multicomponent Vapor-Liquid Equilibrium	Ch. 6.4-6.8	HW7
10	3/16	Types of Energy, Energy Balance Basics, and the Steam Tables	Ch. 7	
11	3/23	Catch-up & Review		HW8, Exam 2*
12	03/30	Nonreactive Energy Balances	Ch. 8	Class Project
13	4/6	Reactive Energy Balances**/ Unsteady-State Processes	Ch. 9**, Ch. 10	HW9
14	4/13	Ethics, Safety, Outlook, Catch-up & Review		Extra Cr., HW10
15	4/20	Catch-up & Review		
4/28		Final Exam		

* Tentative dates. Exact dates will be decided after consulting with students. Please check Canvas for announcements.

** Depending on the course progress, the Reactive Energy Balances** (Ch. 9**) may or may not be covered.

Attendance Policy, Class Expectations, and Make-Up Policy

Attending all class periods is essential in order to perform well in this course, and is therefore required. Attendance and participation will be tracked with TopHat software. Absences will be excused only if you notify your instructor in advance of your absence via email and you provide your instructor with the appropriate documentation. Excused absences must be consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

Cell phones, laptops and other electronics are allowed as educational devices only. Please do not distract others by using electronics for other purposes during class.

Excused absence work make-up

Make-up work will be considered on a case-by-case basis, commensurate with your circumstances in a manner that is fair to you and your classmates. There will be no make-up assignments for unexcused absences.

Evaluation of Grades/Course Assignments

Exams: 3 Total, 600 points; 200 Points Each

Each exam will last two hours, and focus primarily on the material covered since the last exam. The material builds on itself, so all exams are “semi-cumulative”.

The format of the questions will vary, but expect a range of “easy” (roughly 30%), “medium” (roughly 40%) and “challenging” (roughly 30%) parts, with the point values for each question/part clearly labeled. During the exam, you are permitted to use a calculator (any model, provided that it has no communication ability; you also may not share calculators), but are not permitted to refer to books or notes.

Note: Make-up exams will be considered on a case-by-case basis for documented, excused absences or emergencies. However, once you begin an exam, you may not be granted an excused absence for any reason.

Homework: 10 Total, 200 points; 20 points each

Homework will be assigned approximately once per week, and will consist of **4 problems** and an **essay response**.

Homework Problems: The homework problems will be challenging. You should plan to spend at least 5 hours per week developing your solution (if not more). You are permitted to discuss the problems and problem-solving strategies with your colleagues, but you may not breach the Academic Honesty Course Policy (see below).

Your homework submission must include the pages of the assignment, with all requested answers reported in the answer box below the problem statement. Your solutions must include a full description of your problem-solving logic, and should be easy to follow in order to receive full credit (see below)

All homework submissions are to be scanned and submitted via canvas.

Grading of homework problems occurs on the following basis:

Blank or minimal effort – 0 points

Not completed/insufficient work shown – 1 point

Complete and incorrect, but difficult to follow – 2 points

Correct, but difficult to follow **or** incorrect, but presented professionally – 3 points

Correct and presented professionally – 4 points

Essay Response: Writing and communication are essential and undervalued skills of successful, professional engineers. Each week, you will be prompted to craft a written response of 300-400 words that will be graded for content, concision, clarity, and grammar (1 point each).

Due Date: Homework is due by 10 PM on Wednesdays. To incentivize you to start (and finish) homework assignments early, homework submitted by noon on the Monday before the due date will receive two automatic bonus points. **Late homework policy:** Homework submitted up to two hours late (midnight) will earn a maximum of 2 points per problem. Homework submitted up to the posting of the solutions (typically 1-2 days after) will earn a maximum of 1 point per problem. No homework will be accepted after solutions are posted. **No exceptions! Plan for the unexpected, double-check your submission and don't procrastinate.**

Team-Based Project: 100 Points

In the class project, you will work in assigned groups of 3-4 to compose an original material and energy balances problem. More details will be given when the project is assigned in late March.

In-Class Participation and Attendance (100 points)

Participation and attendance will be tracked with TopHat software. Approximately 6 points will be available per class period, but this is subject to change depending on the nature of the material presented on a given day. Some of the TopHat points will be awarded for participation and the rest for correctness of your responses. This percentage might not be disclosed to the class in advance.

With this model, more than 100 points are available, which will account for a grace for unexcused absences and incorrect responses. You may not earn more than 100 course points on the basis of participation and attendance.

This is the first term of TopHat implementation by the course coordinator, and policies are subject to minor change due to unforeseen issues that arise. These changes will be communicated clearly to the class.

Extra Credit: 20 Points Possible

You will have the opportunity to earn a maximum of 20 extra-credit points.

Option 1: Write an original exam/homework questions (maximum of 10 points/question). You must submit the **question statement, an answer key, and an explanation of the concept** that the question is testing. In addition, by submitting these questions, you authorize me to use them in subsequent semesters (or, if the question is good enough, this semester!). You may submit as many questions as you like.

Option 2: Submit a creative expression of your experiences in ECH3023. Submissions may include a song, video, poem, craft, painting, artwork, or any other creation. The constraints are that only one submission is allowed in this category with a maximum of 10 points. In addition, your submission must be completely original, and your submission must be **shared** with the rest of the class on the last day of class.

The deadline to turn in extra-credit is **Monday, April 13, 2019**.

Grading Policy

You may earn 1000 possible points in this course by completing assignments (see above). Your final letter grades will be based on your final point total only (no curve). The official thresholds to earn a given letter grade are listed below:

Point Value	Letter Grade
960-1000	A
920-950	A-
880-910	B+
840-870	B
800-830	B-
760-790	C+
720-750	C
680-720	C-
640-680	D+
600-640	D
0-600	F

At the end of the term, the instructor may add points to all students' scores uniformly to improve grades, but may NOT subtract points to diminish grades.

Students in the "gray areas" (gaps) between grading bins may earn either the next letter grade up, or the next letter grade down based on their professionalism, participation, effort, distance to the next bin, and performance trajectory. Final decisions are based solely on the instructor's discretion. Note that there are no gray areas below C letter grades.

More information on UF grading policy may be found at:
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Regrades:

To submit a regrade, fill out the regrade request form (a blank copy may be found on Canvas). This form will require you to directly state the number of points you think you deserve and a full explanation of the discrepancy (unless it is a simple addition error). **Do not write anything directly on any page of your assignment.** You must scan and upload your entire assignment, with the regrade request as the cover page to Canvas within **one week** of the date the assignment was returned to the class.

E-mail:

In order to ensure a timely response, put "ECH3023" (formatted exactly; all caps, no spaces) in the subject line. You must also use proper e-mail etiquette and professionalism to ensure a response.

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 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 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.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.ua.ufl.edu/public-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://sccr.dso.ufl.edu/policies/student-honor-code-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 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

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: <http://www.counseling.ufl.edu/cwc>, 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://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://care.dso.ufl.edu>.

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