

## **Material and Energy Balances**

ECH3023 Sections (11689)

**Class Periods:** MWR, P2 (9:30-10:45); R, P3 (11:00-12:15)

**Location:** CHE 0237

**Academic Term:** Summer C 2019

### ***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.

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.

#### **E-Mail: [vjtocco@ufl.edu](mailto:vjtocco@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 put "ECH3023" in the subject line.

#### **Office: 219 Chemical Engineering**

#### **Office Hours:** Mondays & Wednesdays after class, 11 AM - Noon

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 by 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.

### ***Exam Dates***

Exam 1: Thursday, June 6, 10 AM – Noon, CHE 0237

Exam 2: Thursday, July 11, 10 AM – Noon, CHE 0237

Final Exam: Thursday, August 8, 10 AM – Noon, CHE 0237

### ***Teaching Assistants:***

**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), 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, 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.

In addition to these learning objectives, we have designed the assignments 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):***

### a. 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.

### b. Student outcomes addressed by the course

Outcome (a): an ability to apply knowledge of mathematics, science, and engineering.

Outcome (d): an ability to function on multi-disciplinary teams.

Outcome (g): an ability to communicate effectively.

## ***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: I will not forbid you from using another edition of the textbook, but keep in mind that is your responsibility (and your responsibility alone!) to ensure that the assigned readings/problems match the 4th edition.*

**Recommended Materials**

Any model of scientific calculator (except those with communication abilities) are permitted for exams and homework assignments. During exams, you may not use your cell phone as a calculator, nor may you share a calculator with a classmate.

Some software or web apps, (such as Microsoft Excel, Wolfram Alpha, or Aspen) may be useful/required for some homework assignments. Therefore, you will need access to this software, which is available on most UF machines. You will not need to use your own personal laptop for any assignments, but you might find it useful.

**Course Schedule – Subject to minor change**

<b>Week</b>	<b>Begins</b>	<b>Topic(s)</b>	<b>Reading</b>	<b>Due</b>
<b>1</b>	5/13	Course introduction, engineering calculations, processes	Ch. 2-3	
<b>2</b>	5/20	Material balance calculations	Ch. 4.1-4.3	HW 1
<b>3</b>	5/27	Material balances on multiple-unit processes	Ch. 4.4-4.5	HW 2
<b>4</b>	6/3	Reactive processes	Ch. 4.6	HW 3
<b>6/6</b>		Exam 1 (During Class Time) – Ch. 2-4		
<b>5</b>	6/10	Single-phase systems	Ch. 5	HW 4
<b>6</b>	6/17	Multiphase systems	Ch. 6.1-6.3	HW 5
<b>7</b>	7/1	Phase Equilibrium	Ch. 6.4-6.8	HW 6
<b>8</b>	7/8	Energy Balance Procedures	Ch. 7	
<b>7/11</b>		Exam 2 (During Class Time) Ch. 5-7		
<b>9</b>	7/15	Nonreactive energy balances	Ch. 8	HW 7
<b>10</b>	7/22	Reactive energy balances	Ch. 9	HW 8
<b>11</b>	7/29	Transient processes	Ch. 10	HW 9
<b>12</b>	8/5	Review & catch-up		HW 10
<b>8/8</b>		Final Exam (During Class Time) Cumulative		

**Attendance Policy, Class Expectations, and Make-Up Policy**

You are required to attend all lectures, but it is on the honor system and we will not monitor or record attendance. Absences will be excused if (and only if) you notify your instructor in advance of your absence via email, your reason for absence is consistent with the UF attendance policy (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>), and you provide your instructor with the 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, 500 points; 200 (or 100) Points Each**

The time limit of each exam is two hours. 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.

Your two highest exam grades (out of three) will be doubled in the final calculation of your course points. For example, if your scores are 64, 88 (176), 81 (162); your total exam points would be 402/500.

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.

#### **Quizzes: 3 Total, 150 points; 50 Points Each**

You may consider the quizzes to be “dress rehearsals” for the exams. Each quiz will occur during lecture time, and will consist of a few conceptual multiple choice, true/false, or short answer questions, totaling 50 points. During quizzes, you may use a calculator, but you may not use books, or notes.

#### **Homework: 10 Total, 200 points; 20 points Each**

Homework will be assigned approximately once per week, and will consist of 4 problems to submit.

Grading occurs on the following basis:

- Blank or minimal effort – 0 points
- Not completed (attempted but not finished or answer guessed) – 1 point
- Incorrect (attempted and complete with major mistakes) – 2 points
- Almost, but not quite (attempted and complete with minor mistakes) – 3 points
- Correct (attempted completely and correctly) – 4 points

The final 4 points is awarded on the professionalism, neatness and logic flow of your solution.

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

Homework is due by 10 PM on Wednesdays. To incentivize you to 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.**

You should complete your homework directly on the assignment, with your final answers reported in the answer box directly below the problem statement. Your solution should begin below your answer, and show all steps needed to understand your procedure. However, you should not include scratch work or every detail (similar to how a textbook shows a solution to an example problem)

You should plan to spend at least 5 hours per week on homework (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).

**Reflective Writing Assignments: Assigned with homework, 50 Points; 5 Points Each**

Writing and communication are essential (although undervalued) skills of successful engineers. Each writing assignment will be a short essay that will be graded for content, grammar, and style. You should write in the “technical” style with clear and concise language (in contrast to the “creative” style, with lyricism, simile, and metaphor).

**Team-Based Project: 100 Points**

In the class project, you will work in assigned groups to compose a material balances problem. Topics will be claimed on a first-come, first served basis, and no duplicate topics are allowed.

More details will be given when the project is assigned.

**Extra Credit: 20 Points Possible**

You will have the opportunity to earn a maximum of 20 extra-credit points by submitting an original exam/homework questions (maximum of 10 points/question) or quiz question (multiple choice, true/false, or short answer; maximum of 2 points/question). Extra credit may not be used to cross the C-/C boundary.

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!).

The deadline to turn in extra-credit is one week prior to the last lecture (i.e. you cannot submit extra credit after you see your final exam grade)

## **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:

<b>Point Value</b>	<b>Letter Grade</b>
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:**

Regrade challenges will be considered for exams and quizzes only (i.e. homework, the team project, reflective writing assignments, extra credit, etc. is not eligible for regrade challenges). There will be a two-point penalty assessed to each regrade challenge that is not overturned, and your entire assignment may be regraded as a result.

Regrade requests for simple addition mistakes or systematic grading errors may be submitted without risk of penalty or whole regrades.

To submit a regrade: On a separate sheet of paper (titled "regrade request"), briefly and clearly state the reason for your request and attach it to the front of the assignment. **DO NOT WRITE ANYTHING DIRECTLY ON ANY PAGE OF YOUR ASSIGNMENT.** You must hand-deliver your regrade request to me (in my office or after class) 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.

### **Students Requiring Accommodations**

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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. In most cases, the instructors are very careful to define permissible and unauthorized aids explicitly, but you are always welcome and encouraged to ask if it ever becomes unclear.

I take this honor pledge very seriously. Cheating is repugnant behavior; it undermines the value of your education, and it is not fair to honest students. I will pursue any violations of the honor code to the maximum possible extent.

While I encourage collaboration on homework assignments, this collaboration is limited to discussion about problem-solving strategies and approximate answers. In completing your homework assignment or studying, you are not allowed to possess, reference, look at, study, or otherwise derive advantage from anything that is not your original work (except reference textbooks and internet references), including other students' work or solution manuals.

### ***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:  
<http://registrar.ufl.edu/catalog0910/policies/regulationferpa.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](mailto: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 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](mailto: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](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf).

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