

# ECH 3023: Material and Energy Balances

**Class Periods:** Section 0674: MWRF Period 6 (12:50-1:40)

**Location:** Section 0674: MAEA 327 (MWRF)

**Academic Term:** Sp. 2024

## A word of advice the instructor of this course

**This is a VERY time-intensive course. It is fun, but it does involve a lot of work. For many of you this is your first semester in Engineering, so our advice is to allocate a minimum of TEN study hours each week (outside of class and help/problem sessions) to master the material for this course. It is the basis of ALL of your future ChE courses and you have to master the material in order to do well. Do ALL of the homework problems. Although there are no team projects, we encourage you to study in groups. The best results occur when you learn collectively and communicate with one another. We hope that you find the course instructive, meaningful, and enjoyable!**

## Instructor: Ranga Narayanan

**E-Mail:** [ranga@ufl.edu](mailto:ranga@ufl.edu)

You must put ECH 3023 in the subject heading to get a response. Please send direct emails to communicate and not via CANVAS

**Office: 419 Chemical Engineering**

**Office Hours:** Monday from 3:00pm -4:00pm and Thursdays 3:00-4:00 PM. Office hours are offered either in-person or via occasionally via zoom (link to be posted on Canvas)

## Supervised Teaching Student: Shrey Agrawal

Email: [s.agrawal@ufl.edu](mailto:s.agrawal@ufl.edu)

Office: To be announced on CANVAS – please revisit the syllabus for an update.

Office hour: (location to be posted on Canvas) Tuesdays 4:00-5:00PM and Friday 8:30-9:30AM

## 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 ought to 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.

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	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 is your responsibility (and your responsibility alone!) to determine the differences between your edition and the 4th edition.*
- All quizzes and exams will be closed book. You will not need to memorize any formulas or tables etc.**

## Required Software

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

Any other software will be open source and you will have access to it when needed.

## Recommended Materials

Any model of scientific calculator may be useful for solving homework and exam problems (when allowed).

## Course Schedule (approximate and tentative)

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/ some unsteady problems
4	Recycle/Bypass, Stoichiometry, Reactive Systems/some unsteady problems
5	Recycle/Bypass, Stoichiometry, Reactive Systems/some unsteady problems
6	Combustion Reactions
7	Ideal Gas Law, Single-Phase Systems, Introduction to Phase Equilibrium
8	Multiphase Systems, Txy & Pxy Diagrams
9	Introduction to Energy Balances/some unsteady problems
10	Thermodynamic Data Tables, Mechanical Energy Balances
11	Non-reactive Systems Involving an Energy Balance
12	Nonreactive Energy Balances
13	More on Nonreactive Energy Balances
14	Chemical Engineering Ethics and Safety
15/16	Review, Course Debrief, and Outlook

### Attendance Policy and Expectations

In-person attendance and participation is expected. You are required to watch all course content videos in advance of class meetings at your own pace. If you are unable to attend class due to an illness, conflict, or emergency, you are expected to notify your instructor in advance.

Requirements for class attendance, exams 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/>

## Exams, Quizzes and Evaluation of Grades

There will be three examinations. EACH EXAM (100 points each) and Quiz (10 points each) will be **CLOSED BOOK.**

**AND CLOSED NOTES. NO ELECTRONIC COMMUNICATION devices will be allowed during exams unless specified in advance.** *You will not need to memorize any formulas or tables etc as key formulas will be supplied.*

*There will NOT be any final examination.* **Exam. Dates: February 21 (Wednesday), March 27 (Wednesday), and April 24 (Wednesday)** commencing at 5:15 pm (unless indicated otherwise). **Please see the eLearning site for locations-** as they will depend on the date of the exam. Each exam will carry 100 points.

Quizzes: There will be **FIVE unannounced quizzes.** These pop quizzes may take place on any Thursday. Each quiz is optional and will carry 10 Bonus points for a total of 50 Bonus points.

Homework: Homework problems will be assigned, but neither collected nor graded. Questions about the homework should be asked during the office hours or after class. **Doing the homework is crucial and important to master the material and to do well on the exams/quizzes.**

## Make-Up Policy

There will not be any make up quizzes. Quizzes constitute bonus points , Therefore, if you miss a quiz for any reason you will not get any points for the quiz.

Exam absences are not permitted unless you are sick or ill. In that case you must give proper certification that you were sick and could not take the exam.

## Evaluation of Course Grades

**Grading Table (out of 300 points- A student can earn a maximum of 350 points if they score perfect on all exams and quizzes).**

POINTS	Grade	Grade Points
>280	A	4.00
255-279	A-	3.67
230-254	B+	3.33
205-229	B	3.00
180-204	B-	2.67
155-179	C+	2.33
145-154	C	2.00
120-144	C-	1.67
90-119	D+	1.33
80-89	D	1.00
60-79	D-	0.67
<60	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>

## Course Format

All required course materials and resources (except the textbook) for ECH 3023 will be contained on, or linked from, the course **Canvas page**. It will also serve as the primary means of communication with your classmates and instructors outside of class. You should get into the habit of checking this Canvas page regularly for announcements and action items. You should also enable Canvas to send you e-mail notifications, such that you are alerted to any updates or correspondence (the default state is "on", so no action is required unless you've disabled this feature).

### 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.

### ***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/>.

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### ***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 Graduate Program Coordinator
- HWC OE Human Resources, 352-392-0904, [student-support-hr@eng.ufl.edu](mailto:student-support-hr@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto: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](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:** <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](mailto: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 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>.