

# Separations and Mass Transfer Operations

**ECH 4403**

**Class Periods:** M,W,F Period 7 (1:55pm – 2:45pm)

**Location:** LAR 310

**Academic Term:** Fall 2023

## Instructor

Prof. Joshua Moon

[joshua.moon@ufl.edu](mailto:joshua.moon@ufl.edu)

Office phone: +1 (352) 392-4752

Office hours: Tuesdays (10:30am – 12:30pm) or by appointment

Office hours location: NEB 331

*Email is my preferred method of communication outside of class. Please include “ECH4403” in your email subject line to ensure that I see your message and reply. I try to reply to emails in a timely manner; however, emails sent late during the weekend may not receive replies until Monday.*

## Supervised Teaching Student

Jisu Shin

[jisu.shin@ufl.edu](mailto:jisu.shin@ufl.edu)

Office hours: TBD

## Course Description

(3 credits) Theory, design, and evaluation of diffusional and staged mass transfer principles including distillation, absorption, and extraction, leaching and membrane separations. Computer-aided design methods.

## Course Pre-requisites / Co-requisites

Prerequisites: ECH3101 (Process Thermodynamics), ECH3202 (Fluid and Solid Operations), and ECH3223 (Energy Transfer Operations)

## Course Objectives

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

1. Explain the fundamental concepts of chemical engineering separation processes.
2. Design distillation equipment for binary or multicomponent mixtures in continuous and batch operation.
3. Design absorption and stripping operations.
4. Design liquid-liquid extraction operations.
5. Design distillation equipment for complex (azeotropic) distillation systems.
6. Understand and design membrane separation systems.

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)

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	High
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	Medium
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	Low

## Required Textbook and Software

- Separation Process Essentials (1<sup>st</sup> Ed.) by Alan M. Lane (CRC Press), ISBN 971-1138086081
- Microsoft Excel and/or Python will be required for some homework assignments. Therefore, you will need access to this software on your personal computer.

## Recommended Materials

- Separation Process Principles (3<sup>rd</sup> or 4<sup>th</sup> Ed.) by J. D. Seader, Ernest J. Henley, D. Keith Roper (Wiley), ISBN 978-1119239598
- Unit Operations of Chemical Engineering (7<sup>th</sup> Ed.) by W. McCabe, J. Smith, P. Harriott (McGraw Hill), ISBN 978-0072848236
- Any model of scientific calculator may be useful for solving homework and exam problems.

## Course Schedule (*subject to change*)

Week	Topic(s)
1 (Aug 23)	Course overview, vapor liquid equilibrium (VLE)
2 (Aug 28)	Txy and XY diagrams, flash distillation
3 (Sept 6)	Flash distillation operating lines, flash distillation energy balances
4 (Sept 11)	Multistage (continuous) distillation, continuous distillation operating lines
5 (Sept 18)	McCabe-Thiele method for multistage distillation, design and analysis problems
6 (Sept 25)	Multistage distillation energy requirements
7 (Oct 2)	Single stage batch distillation
8 (Oct 9)	Multistage batch distillation, column design and efficiency
9 (Oct 16)	Single and multistage absorption and stripping
10 (Oct 23)	Concentrated solute absorption and stripping
11 (Oct 30)	Ternary phase diagrams, single stage liquid-liquid extraction (LLE)
12 (Nov 6)	Crosscurrent liquid-liquid extraction
13 (Nov 13)	Countercurrent liquid-liquid extraction
14 (Nov 20)	Azeotropic distillation
15 (Nov 27)	Pressure-swing distillation
16 (Dec 4)	Gas separation and water purification membranes
17 (Dec 14)	Final exam

## Course Format, Attendance Policy, and Expectations

Attendance is expected and strongly recommended but will not be officially monitored or graded. Please be punctual to minimize distractions to your fellow students.

This course will be taught primarily through in-class lectures which will include some guided problem-solving exercises. Simply attending class is not sufficient to ensure success in this course – it is expected that students will proactively supplement in-class activities by working additional problems at home.

All required course materials and resources (except the textbook) for ECH 4403 are contained on, or linked to, the course Canvas page. This page serves 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 so 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).

When interacting with fellow students and instructors, you are expected to maintain professionalism and behave respectfully. This includes using proper email etiquette. The community of ECH 4403 will be supportive and inclusive. Offensive imagery and/or language will not be tolerated in any capacity.

Any changes to the format of this course will be clearly communicated to you by your instructor. Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with University policies that can be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>

## Course Assignments

- **Homework Assignments** will be given no more than once per week and will generally be due the following week. Late assignments will not be accepted.
  - Homework will be graded based on completeness, correctness, and presentation/formatting as submitted.
  - **Low-Score Drop for Homework:** Each student’s lowest homework score will be automatically dropped at the end of the semester. This policy covers both technological issues and emergencies, and no further accommodations, deadline extensions, or drops for homework will be granted for technological issues or emergencies. Assume that issues may arise at the worst possible time (e.g., your computer may crash right before homework is due), and plan ahead for contingencies.
    - The last homework assignment in the course will be a survey of other separation processes we did not cover in class, and this assignment cannot be dropped.
  - You are permitted to discuss homework problems and problem-solving strategies with your colleagues in this class, but you may not breach the Academic Honesty Course Policy (see below). Each student must submit a unique and independently written submission, and plagiarism will not be tolerated.
  - The format of your homework submissions must follow all the instructions provided on the course Canvas page to receive full credit. Your solutions must include the problem statements with all answers reported in the answer box below the problem statement. Your solutions should include clear descriptions of problem-solving logic, should be organized neatly, and should be easy to read and follow.
  - All homework submissions are to be scanned and submitted as a single PDF or Word file via Canvas. Photographs and image files are not acceptable and will be penalized.
- **3 Midterm Exams** will be given throughout the semester. The format, date, and time for each midterm exam will be announced at least two weeks in advance.
  - During the midterm exams, you are permitted to use any model calculator, provided it has no communication ability. You may not share calculators.

- Students who do not attend an exam at the scheduled time will receive a score of zero for that exam. See make-up policy below.
- **Low-Score Replacement for Midterm:** At the end of the semester, if your score on the final exam is higher than at least one of your midterm exam scores, your final exam score will replace your one lowest midterm exam score.
  - For example, if a student scores 80 on their homework, 72, 77, and 89 on their midterm exams, and 81 on their final exam, the 72 would be replaced with an 81. Their final grade in the class would be  $80*0.2$  (homework) +  $81*0.2$  +  $77*0.2$  +  $89*0.2$  (midterms) +  $81*0.2$  (final) = 81.6.
- **A Final Exam** will be given at the end of the semester on December 14 at 10:00am-12:00pm.
  - The final exam will be cumulative.
  - During the final exam, you are permitted to use any model calculator, provided it has no communication ability. You may not share calculators.

### Grading Policy

Assignment	Total Points	Percentage of Final Grade
Homework (8)	100 each	20%
Midterm Exam 1	100	20%
Midterm Exam 2	100	20%
Midterm Exam 3	100	20%
Final Exam	100	20%

Your final letter grade will be based on your average score at the end of the course. Grades may be curved depending on class performance. *The following table is approximate and is subject to modification.*

Average Score	Grade	Grade Points
93.34 – 100	A	4.00
90.00 – 93.33	A-	3.67
86.67 – 89.99	B+	3.33
83.34 – 86.66	B	3.00
80.00 – 83.33	B-	2.67
76.67 – 79.99	C+	2.33
73.34 – 76.66	C	2.00
70.00 – 73.33	C-	1.67
66.67 – 69.99	D+	1.33
63.34 – 66.66	D	1.00
60.00 – 63.33	D-	0.67
0 – 59.99	E	0.00

**Regrades:** To request a regrade, you must email your Instructor or ST within one week of the day that the assignment or exam is returned to the class as graded. Requests submitted after this deadline will not be honored. In your request, clearly explain the discrepancy and which problem you wish to be regraded. Be aware that there is a possibility your score may decrease after the regrade if additional errors are found.

More information on UF grading policy may be found at <https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/>

## **Make-Up Policy**

Requests for make-up exams will be considered only for those students who missed due to an acceptable reason. There will be no make-up homework assignments. Excused absences must be consistent with University policies in the undergraduate catalog and require appropriate documentation. Additional information can be found at <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>. It is required that, whenever possible, the student notifies the instructor about the situation prior to the exam, preferably at least one week in advance.

## **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/>. Students requesting accommodations should share their accommodation letter provided by the Disability Resource Center 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 online evaluations online via GatorEvals. Such feedback is highly valuable for improving the learning experiences of students in this and other courses in subsequent semesters. 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/publicresults/>.

## **Public Health Policy**

This class will follow University guidelines regarding public health policies. More information about University guidance can be found at <https://wellness.ufl.edu/>. Any changes to this policy will be clearly communicated to you by your instructor.

If you are sick with any potentially contagious illness (such as the flu or COVID), stay home, self-isolate, and do not attend class or in-person office hours until you have recovered. Seek medical attention if needed. Contact your instructor as soon as possible to inform them of which dates you will be absent in order to make up the material or activities covered during your absence in a timely manner.

## **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 Policy on Academic Conduct**

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 honesty 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 (<http://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. If you have any questions or concerns, please consult with the Instructor or ST (TA) 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
- Jennifer Nappo, Director of Human Resources, 352-392-0904, [jpennacc@ufl.edu](mailto:jpennacc@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/>

### **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:** 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

#### **Campus Resources: Academic Resources**

- **E-learning (Canvas) 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:** <https://www.distance.ufl.edu/student-complaint-process>.

#### **Disclaimer**

This syllabus represents my current plans and objectives. As we go through the semester, those plans may need to change to enhance the class learning opportunity. Such changes, which will be clearly communicated to you by email or via the course Canvas website, are not unusual and should be expected.