

Separation and Mass Transfer Operations

ECH4403 Class #20719, Section 13LF

Class Periods: Asynchronous Online

Location: Online via Canvas

Academic Term: Summer 2024

Instructor:

Name: LiLu Tian Funkenbusch, Ph.D.

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Office: CHE219 (Note that I typically work from home unless required to be on campus)

Office Hours: *Virtual* (link [here](#)), by appointment (email)

*You may call me Prof./Dr. Funkenbusch, or LiLu. Remember that calling instructors by their first names must encompass the same level of professionalism and respect as using titles. Please do not call me Miss/Ms./Mrs.

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

Course Objectives

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

Materials and Supply Fees: None

Suggested Textbook

- Separation Process Engineering by Philip Wankat, ISBN 0131382276
 - Note: I will not assign reading or specific textbook problems. They are strongly encouraged as practice/review. The textbook is only a resource/reference, not required.

Required Software/Materials

- Microsoft Excel and/or Python will be needed for some homework problems. Aspen HYSYS will also be required for some assignments. Therefore, you will need access to these softwares on your personal laptop. If you are an in-person student, I recommend bringing your laptop to class so you can follow along with in-class example problems.
- Any model of scientific calculator may be useful for solving homework problems.

Course Format: Lectures:

All lectures will be recorded and listed in the modules.

Course Format: Canvas:

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

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

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Course Schedule:

Module	Topic(s)
1	Orientation & Course Introduction
2	Equilibria Basics
3	Distillation – Intro & Single Stage
4	Distillation – Multistage
5	Distillation – Multicomponent
6	Distillation – Batch
7	Distillation – Design of Columns
8	Distillation – Azeotropes
9	Absorption & Stripping
10	Liquid-Liquid Equilibria
11	Packed Bed Analysis
12	Membranes
13	Cooling Towers

Attendance Policy, Class Expectations, and Make-Up Policy

Watching lectures online is expected but will not be monitored or graded. You are accountable for ensuring that your course performance is to your satisfaction and standards, including attending class regularly or watching lectures online.

If you miss a lecture, even for a university-recognized reason, **you** are expected to access the online recording of what you missed. The instructor will not provide written/typed notes to students who are absent, regardless of the reason.

When interacting with fellow students and instructors, you are expected to maintain professionalism and behave respectfully. The community of ECH4403 will be supportive and inclusive. Offensive imagery and/or language will not be tolerated in any capacity.

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.

Evaluation of Grades

Assignment	Worth
Homework (~6*)	800 pts total*
Final Project	200 pts
Total	1000 pts

*Exact number of homework assignments may change, depending on our pace in the course. Point values may shift accordingly, but the overall points for homework will remain at 800 points.

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

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

Regrading Policy

You are welcome to submit an assignment for regrading if you follow the basic guidelines below:

- You must request a regrade within a week of the assignment being returned as graded.
- You must submit detailed comments/replies to the annotated PDF of your assignment (download via Canvas), with specifics on why/where you think you should get points back.
 - The obvious exception is if I made a mathematical error when totaling your score. If that is the case, please notify me of the error quickly and I will redo the math.
- I will take a longer, closer look than the first time. **You may earn a lower score as a result.**

Homework:

- Expect the homework problems to challenge you. I 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. You are permitted to discuss the problems and problem-solving strategies with your classmates, but you may not breach the Student Code of Conduct or specific guidelines given on the homework assignments.
- **Solution Submission:** Homework is to be submitted electronically on Canvas. Your homework solution must include your worked-out solutions and any program files (Excel, Python, HYSYS, etc.) that you used to solve the problems.
- 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 handwriting solutions and scanning them.
 - 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 me know if access to this technology is unavailable, and accommodation will be made.
- **Grading:** Grading of problems will follow this outline. Specific point values will vary depending on the assignment.
 - 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
- **Due Date:** Homework is due at 11:59 PM on the due date and graded *as submitted*. You are responsible for ensuring your submission is complete and on time. No late assignments will be accepted without prior instructor approval due to university-recognized reasons (illness, etc.). **The Canvas assignments will be locked automatically at 11:59pm.**
- No accommodation or deadline extensions for homework will be granted due to technological issues or emergencies. You should anticipate these issues and plan contingencies or submit them early.

Final Project:

- Phase 1: Students will choose a separations technique based in the bio-pharmaceutical industry (there is a list below, but you may choose something else with instructor approval).
 - Centrifugation
 - Depth Filtration
 - Dead-End Filtration
 - Tangential Filtration
 - Affinity Chromatography
 - Ion Exchange Chromatography
 - Size Exclusion Chromatography
 - Hydrophobic Interaction Chromatography
 - Aqueous Two-Phase Extraction
- Phase 2: Students will research their separations technology. Students will prepare an outline with an introduction to the technology, how it works, and some specific applications of it in industry. Students will find at least **three** credible sources for this assignment (and the next phases). Note that the target audience is your classmates, who have basic ChemE knowledge but are not well-versed in bio-pharmaceutical techniques.
- Phase 3: Students will submit a PowerPoint presentation based on their outline (with instructor comments considered). The presentation should be 10-15 slides. Further requirements/guidelines will be provided via Canvas.
- Phase 4: Students will record a 10-minute presentation and upload to Youtube or similar. This must be accessible by the instructor and classmates.
- Phase 5: Students will watch their peers' videos, then fill out peer evaluations and give comments.

Extra Credit: 25 points possible total, due Tuesday August 8

- Write an original exam/homework problem. You must submit the problem 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. You may submit as many questions as you like.

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.a.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.a.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.

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
- 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>

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. No consultation among students is allowed during quizzes.

Plagiarism

Students are not permitted to represent as their own work any portion of the work of another person. Plagiarism includes (but is not limited to) submitting a document or assignment which in whole or in part is identical or substantially identical to a document or assignment not authored by the student. All sources used in preparation of the reports should be cited, including the manuals provided on Canvas. Failure to do so is considered plagiarism.

Note: Self-plagiarism is also an issue and will be punished as if the student plagiarized someone else’s work. You must cite any figures or information taken from other reports. This is the academic standard and is largely due to journal copyright issues when publishing papers.

Falsification of Information

Students are not permitted to use or report any invented or fabricated information or data. This includes both experimental results and theoretical calculations.

Sanctions for Violations of Honor Code

Since ethical behavior in science and engineering is equal in importance to specific knowledge, the instructor will assign a non-passing letter grade to students who violate academic honesty standards, regardless of the violator's grade performance in class.

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://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/state-authorization-status/#student-complaint>.