

## Separation and Mass Transfer Operations Laboratory

ECH 4404L Section 1991/7297/TEST

**Class Periods:** W/R/F Periods 2-5 (8:30am-12:35pm)

**Location:** CHE Unit Operations Lab (100, 200, 300), NRF

**Academic Term:** Fall 2020

### **Instructor:**

Dr. LiLu Tian Funkenbusch

[lilu.funkenbusch@ufl.edu](mailto:lilu.funkenbusch@ufl.edu)

Office Hours: M 9am-12pm or by appointment (Zoom link on Canvas)

### **Teaching Assistant/Peer Mentor/Supervised Teaching Student:**

Please contact through the Canvas website

	Wednesday	Thursday	Friday
BD	Noah Wentzel	Nico Macaluso	Holden Young
CD	X	X	X
LLE	Danielle Harrison	Nishi Ravindran	Jason Miller
CT	Jason Miller	Marco Padilla	Marco Padilla
SM1+2	Keilani Medvec	Bochuan Song	Keilani Medvec

### **Course Description:**

Laboratory work in unit operations involving separation and mass transfer; 2 credit hours.

### **Course Pre-Requisites:**

ECH 4403 (Separation Processes), ECH 4424L (Unit Ops Lab I), ECH 4714L (Safety and Experimental Evaluation)

### **Course Objectives**

1. Reinforce classroom theory by the collection and use of data in practical experiments with all their inherent problems and limitations.
2. Gain proficiency in writing technical reports.
3. Gain experience working in teams.
4. Create a sense of professional responsibility for the quality and integrity of engineering work.
5. Learn safe working procedures.
6. Learn equipment, instrumentation, and procedures not covered in lectures.

### **Materials and Supply Fees:**

Lab Fee: \$223.68

**Required Textbooks and Software:** none

### **Recommended Materials**

- Geankoplis, C. J., Transport Processes and Unit Operations [On reserve in the Science Library].
- Incropera, F. P. and D. P. DeWitt, Fundamentals of Heat and Mass Transfer [On reserve in the Science Library]
- McCabe, W. L., J. C. Smith, and P. Harriet, Unit Operations of Chemical Engineering [On reserve in the Science Library]
- Perry, R. H., D. W. Green, and J. O. Maloney, Perry's Chemical Engineers' Handbook [E-book is available through UF Library website]

### **E-Learning:**

The Canvas website (<http://elearning.ufl.edu/>) has all relevant documents and will be used for submission of reports and posting of grades and announcements.

**Professional Component (ABET):** This course is focused on experimental studies of thermodynamics and heat and momentum transfer in the context of unit operations. Theoretical concepts learned in other courses are illustrated by experiments. Technical communications are emphasized.

**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	Low
3. An ability to communicate effectively with a range of audiences	High
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	High
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	High
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	High

\*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

The course consists of the following six experimental modules:

- BD: Batch Distillation (3 memos)
- CD: Continuous Distillation (3 memos) \*online
- CT: Cooling Tower (3 memos)
- LLE: Liquid-Liquid Extraction (3 memos)
- Semiconductors 1: (2 pre-lab homework and 2 post-lab reports)
  - A-Oxide Growth
  - B-Thermal Evaporation
- Semiconductors 2: (2 pre-lab homework and 2 post-lab reports)
  - A-Photolithography
  - B-Wet and Dry Etching

Each module is two weeks long. Each course section is divided into teams, which rotate through all modules except for continuous distillation, which will be done by all groups at the same time. Each team member is responsible for understanding all elements of each project. I suggest you divide the workload and rotate who is responsible for what. \*See Canvas page for group assignments and detailed schedule.

The planned schedule is shown below (see Canvas page for a larger version) but is subject to change.

	Red Team	Orange Team	Yellow Team	Green Team	Blue Team
Start Date					
End Date					
Aug. 31	Orientation & Safety Training, Continuous Distillation Simulation & Analysis				
Sept. 4					
Sept. 7					
Sept. 11					
Sept. 14	Batch Distillation	Semiconductors 2A	Semiconductors 1A	Liquid Liquid Extraction	Cooling Tower A
Sept. 18		Semiconductors 2B	Semiconductors 1B		Cooling Tower B
Sept. 21					
Sept. 25					
Sept. 28	Cooling Tower A	Batch Distillation	Semiconductors 2A	Semiconductors 1A	Liquid Liquid Extraction
Oct. 2	Cooling Tower B		Semiconductors 2B	Semiconductors 1B	
Oct. 5					
Oct. 9					
Oct. 12	Liquid Liquid Extraction	Cooling Tower A	Batch Distillation	Semiconductors 2A	Semiconductors 1A
Oct. 16		Cooling Tower B		Semiconductors 2B	Semiconductors 1B
Oct. 19					
Oct. 23					
Oct. 26	Semiconductors 1A	Liquid Liquid Extraction	Cooling Tower A	Batch Distillation	Semiconductors 2A
Oct. 30	Semiconductors 1B		Cooling Tower B		Semiconductors 2B
Nov. 2					
Nov. 6					
Nov. 9	Semiconductors 2A	Semiconductors 1A	Liquid Liquid Extraction	Cooling Tower A	Batch Distillation
Nov. 13	Semiconductors 2B	Semiconductors 1B		Cooling Tower B	
Nov. 16					
Nov. 20					
Nov. 23					
Nov. 27					
Nov. 30	W/F last week*, Final Reports Due, Make Up Labs				
Dec. 4	W/F last week*, Final Reports Due, Make Up Labs				
Dec. 7	Make Up Labs				
Dec. 11	Make Up Labs				

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

- Students are required to attend all lab sessions. This includes on-campus and online meetings, depending on the individual student's rotation schedule.
- 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. Telling me earlier is better! **Excused absences should be made up, if possible**, for completion of all learning objectives, but grades will not be impacted due to an excused absence.
- Unexcused absences and/or tardiness will result in grade reductions.
  - An unexcused absence without a make-up will result in **failure of the module**.
  - A made-up unexcused absence will still result in **25% grade reduction** for that module.
- Tardiness (>5 minutes) will result in a **10% grade reduction** for that module unless an emergency occurs (such as the bus breaking down).
- Make Up Labs: To make up for a missed lab, the students will perform the missed experiment during the last two weeks of the semester with any other students who may have missed the same experiment.

\*Highlighted items are subject to change.

### **Evaluation of Grades**

Assignment	Worth
Orientation Quiz	50 pts
Safety Homework	50 pts
Quizzes (x4)	25 pts each
First Memo (x4)	50 pts each
Second Memo (x4)	75 pts each
Third Memo (x4)	100 pts each
SM Pre-Labs (x4)	25 pts each
SM Post-Labs (x4)	75 pts each
Peer & PT/ST Evaluations, Participation	100 pts
<b>Total</b>	<b>1600 pts</b>

\*The participation grade will be based on peer tutor feedback, peer evaluations, and instructor observations. A failing grade for participation will result in a failing course grade.

### **Grading Policy**

Percent	Grade	Grade Points
94.0 – 100.0	A	4.00
90.0 – 93.9	A-	3.67
87.0 – 89.9	B+	3.33
84.0 – 86.9	B	3.00
80.0 – 83.9	B-	2.67
77.0 – 79.9	C+	2.33
74.0 – 76.9	C	2.00
70.0 – 73.9	C-	1.67
67.0 – 69.9	D+	1.33
64.0 – 66.9	D	1.00
60.0 – 63.9	D-	0.67
0.0 – 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>

## **Safety**

Students are expected to know and follow safe operating procedures of the equipment as well as proper handling of hazardous materials. The students are required to attend a safety orientation session at the beginning of the semester. **Failure to follow safe operating procedures will result in a significant grade reduction.** Examples of safety violations are listed below (this list is not exhaustive):

<b>Safety violation</b>	<b>Penalty</b>
Leaving the lab without shutting down an experimental system	Failing grade
Not wearing PPE required by an experiment	Letter grade reduction
Not disposing of hazardous waste properly	Letter grade reduction
Not handling a chemical spill properly	Letter grade reduction
Causing a spill due to negligence (e.g., by opening wrong valves).	Letter grade reduction
Bringing food or drink into the lab	Letter grade reduction

## **Memo Policy**

- All memos should be completed as a group. These should be submitted via Canvas as a Word or PDF file.
  - a. 1<sup>st</sup> Memo: Due midnight the day before the 1<sup>st</sup> run day
  - b. 2<sup>nd</sup> Memo: Due midnight the day before the 2<sup>nd</sup> run day
  - c. 3<sup>rd</sup> memo: Due midnight one week after the 2<sup>nd</sup> run day
- **A failing grade for that lab will be assigned to groups who do not submit a first memo.**
- Late submissions will be accepted only if a group was not able to complete the assignment on time due to an acceptable reason (see the attendance policy).

## **Pre-lab Homework Policy**

- Pre-lab homework should be completed individually by each student and is due 24 hours before each new experiment. Pre-lab homework should be submitted via Canvas as a Word or PDF files.
- Late submissions will be accepted only if a student was not able to complete the homework on time due to an acceptable reason (see the attendance policy).

## **Quiz Policy**

- Quizzes are scheduled on Canvas for the day before each new on-campus experiment. They will be available for a 24-hour window starting at midnight and ending at 11:59pm of that day.
- Quizzes will be rescheduled only for those students who cannot take them due to an acceptable reason (see the attendance policy). The student should notify the instructor about the situation as soon as possible to allow adequate time to find an alternative time.
- Students may not use notes, manuals, or any other material during the quizzes.
- A cumulative score of <50% will result in failure of the individual for the course.

### ***Schedule for each experiment:***

#### Before the experiment:

1. Review manual and operating instructions posted on Canvas.
2. If necessary, meet with the instructor to discuss the upcoming experiment.
3. Answer pre-lab questions posted on Canvas as an individual or complete the first memo as a group.

#### During the experiment:

1. Take the quiz individually (Day 1)
2. Your group's experimental design will be reviewed by the Peer Tutor and will contribute to your lab participation grade (Day 1)
3. Get acquainted with equipment
4. Learn proper start-up and shutdown procedures
5. Learn how to perform measurements
6. Learn about limits of the system
7. Experiment with the system under various conditions
8. Perform basic checks of your data (e.g., mass and energy balances) during the experiment. Avoid a situation in which you collect data just to discover that it does not satisfy the mass or energy balance **after** you are out of the lab and writing your report. It is necessary to perform the basic checks **during** the lab and repeat an experiment, if necessary.

#### After Day 1 of the experiment:

Analyze your data and write the second memo or a post-lab homework. Memos are group assignments; post-lab homework are individual assignments. You are required to submit the following:

1. 2<sup>nd</sup> memo for: Continuous Distillation, Batch Distillation, Cooling Tower, and Liquid-Liquid Extraction.
2. Post-lab homework for: Oxide Growth or Photolithography

#### After Day 2 of the experiment:

Analyze your data and write a report or a post-lab homework. All reports and post-lab homework are group assignments. You are required to submit the following:

1. 3<sup>rd</sup> Memo for: Continuous Distillation, Batch Distillation, Cooling Tower, and Liquid-Liquid Extraction.
2. Post-lab homework for: Thermal Evaporation or Etching

### ***Guidelines for Assignments***

1. Guidelines and grading rubrics are posted on Canvas. Reports will be graded on both technical content and communication effectiveness.
2. Reports should be written using complete sentences, with correct spelling and grammar. All symbols should be defined on their first use. Clarity and brevity will be rewarded; sloppy thinking and writing will be penalized.
3. Do not copy theoretical derivations from a textbook or a website. Instead, clearly state assumptions behind a derivation, provide relevant derivation results, and cite your sources.
4. All reports should be submitted via e-learning either in Word or PDF format. No need to submit hard copies.
5. In addition to a report file, your submission should contain all supporting information, such as spreadsheet files with your data and files with your computer codes. However, your reports should be self-contained, i.e. one should be able to understand your work by reading your report without referring to supporting materials.
6. **Late submissions will be penalized by a 10% grade reduction for each day the report is overdue.**

### ***Guidelines for Experiments and Data Analysis***

1. Check energy and material balances.
2. Investigate effects of all control parameters on the experimental results.
3. Almost all experiments should be performed at a steady state. Exceptions are the batch filtration and the 3-tank experiments.
4. Clearly identify and justify all assumptions in your theoretical calculations.
5. Compare the measured data with your theoretical calculation.
6. Check reproducibility of your data. Whenever possible, **perform at least three runs for each experimental condition** and obtain error estimates by computing standard deviations based on these runs. Report the average values and error estimates in the main text of the report and provide an appendix containing data for all experimental runs.
7. Report any anomalous results and discuss their possible sources.
8. Use spreadsheets (e.g., Excel or OpenOffice) to store your data. Use Python (or another equivalent programming language) for data analysis and theoretical calculations. Use of spreadsheets for complex calculations is discouraged due to difficulty of their debugging.
9. Make sure that your objectives can be met with your operating conditions. It is easy to choose conditions that are outside of the performance limits of the apparatus or produce results with no measurable difference. Carefully study the limitations of the existing experimental apparatus as a part of the planning process rather than finding out in the laboratory that the experimental values obtained are useless.

### ***Online Course Recording***

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

### ***F2F Course Policy in Response to COVID-19***

We will have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

- You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements are all of our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution and not being allowed into the lab.
- This lab has enough capacity to maintain physical distancing requirements. Please maintain appropriate spacing when possible. Experiments may require temporarily being closer to maintain chemical/physical safety.
- Sanitizing supplies (hand sanitizer, wipes, etc.) are available in the lab. We use these supplies between course session to wipe down common touch surfaces.
- Only enter and exit the lab on the appropriate floor through the main set of doors. Practice physical distancing to the extent possible when entering and exiting the lab. You should sanitize or wash your hands before and after coming to the lab.
- If you are experiencing COVID-19 symptoms ([Click here for guidance from the CDC on symptoms of coronavirus](#)), please use the UF Health screening system and follow the instructions on whether you are able to attend class. [Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms](#).
- With an excused absence, you will be given a reasonable amount of time to make up work. If at all possible, you should make-up the lab session, but depending on the timing/situation, this may not be possible, and your grade will not suffer as a result.



### ***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 lab assistants in this class.

### ***Cooperation Policy***

- Students are expected to work in teams on their experiments and memos.
- Individual assignments, such as pre-labs and post-labs, should be completed by each student individually.
- 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 the Canvas webpage.

### ***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.

### ***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/>.

### ***Writing Requirement***

This course confers 6000 words towards the Writing Requirement (WR), which ensures students both maintain their fluency in writing and use writing as a tool to facilitate learning. While helping students meet the broad learning outcomes of content, communication, and critical thinking, the instructor will evaluate and provide feedback on students' written assignments with respect to grammar, punctuation, clarity, coherence, and organization

Course grades have two components. To receive Writing Requirement credit, a student must receive a grade of C or higher and a satisfactory completion of the writing component of the course.

### ***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](mailto:rbielling@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:** <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](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](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://care.dso.ufl.edu>.

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