

## Separations and Mass Transfer Operations

ECH 4403 Section 1573

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

**Location:** PSY 0151

**Academic Term:** Fall 2021

### **Instructor:**

Prof. Won Tae Choi

[wontae.choi@ufl.edu](mailto:wontae.choi@ufl.edu)

(352)392-9102

Office Hours: TBD

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

No. TA assigned to this course. Please contact Prof. Choi directly through the Canvas website

### **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**

ECH 3101 – Process Thermodynamics

ECH 3202 – Fluid and Solid Operations

ECH 3223 – Energy Transfer Operations

ECH 3264 – Elementary Transport Phenomena

### **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 adsorption or stripping operations
4. Design liquid-liquid extraction operations
5. Design distillation equipment for complex (azeotropic) distillation 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**

Homework assignments, announcements and grades will be posted on Canvas. Please check Canvas page regularly.

### **Relation to Program Outcomes (ABET):**

The table below is an example. Please consult with your department's ABET coordinator when filling this out.

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 Textbooks**

- Separation Process Essentials (1<sup>st</sup> Edition) by Alan M. Lane (CRC Press) ISBN 978-1138086081

### **Required Software**

- Microsoft Excel and/or python software will be strongly encouraged/required for some homework problems. Therefore, you will need access to this software on your personal laptop.

### **Recommended Materials**

- Separation Process Principles, 3<sup>rd</sup> Edition, J. D. Seader, Ernest J. Henley, D. Keith Roper (Wiley), ISBN: 978-1119239598
- Separation Process Engineering, 4<sup>th</sup> Edition, Phillip C. Wankat (Pearson) ISBN: 978-0131382275
- Unit Operations of Chemical Engineering, 7<sup>th</sup> Edition, W. McCabe, J. Smith, P. Harriott (McGraw Hill), ISBN: 978-0072848236
- Other recommended reading materials and articles will be suggested during classes.
- Any model of scientific calculator may be useful for solving homework and exam problems.

### **Course Schedule (subject to change)**

Week 1:	Course introduction, phase equilibrium, single-stage distillation
Week 2:	Graphical solutions to problems, energy requirements
Week 3:	Multi-stage distillation
Week 4:	Distillation column design and variations
Week 5:	Distillation column practice
Week 6:	Multicomponent distillation
Week 7:	Batch distillation
Week 8:	Absorption and stripping columns
Week 9:	Multicomponent/adiabatic absorption
Week 10:	Column design and practical aspects of separation process
Week 11:	Liquid-liquid extraction
Week 12:	Liquid-liquid extraction (continued)
Week 13:	Azeotropic/non-ideal separation processes
Week 14:	Membrane separation
Week 15:	Review

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

**You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.** Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email [covid@shcc.ufl.edu](mailto:covid@shcc.ufl.edu)) to be evaluated for testing and to receive further instructions about

returning to campus. UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.

**Dates for Exams will be announced at least 2 weeks in advance.** Students who do not attend an exam at the scheduled time will receive a score of zero for that exam. **Requests for make-up exams will be considered only for those students who missed due to an acceptable reason.** 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. It is required that, **whenever possible, the student notifies the instructor about the situation prior to the exam, preferably at least two weeks in advance**

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: <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

### ***Evaluation of Grades***

<b>Assignment</b>	<b>Total Points</b>	<b>Percentage of Final Grade</b>
Homework Sets	150	30%
Exam 1	100	20%
Exam 2	100	20%
Final Exam	150	30%
<b>Total</b>	<b>500</b>	<b>100%</b>

**Homework assignments** will be given no more than once per week, generally due the following week. Late homework will not be accepted. Your homework submission must include the pages of the assignment, with all requested answers reported in the answer box below the problem statement. Your homework solutions must include a full description of your problem-solving logic and should be easy to follow in order to receive full credit. 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).

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

Essay responses will be graded for content, concision, and clarity.

### **Exams: 2 Midterms (Exam 1 & Exam 2) and 1 Final**

2 h-time-limited two Midterms (Exam 1 & Exam 2) and 2 hours Final (12/15/2021, 10:00 AM – 12:00 PM) will be assigned. Format and Date/Time for the Exams will be announced at least 2 weeks in advance. The final exam is cumulative. During the exams, you are permitted to use a calculator (any model, provided that it has no communication ability; you also may not share calculators).

### ***Grading Policy***

The grades will be curved. Depending on the class performance, B or B+ will correspond to the class average, which will be determined as shown in the Evaluation of Grades section.

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

### ***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/>.

### ***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 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 Conduct 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. 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 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.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](mailto:title-ix@ufl.edu), 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/>.

##### **COVID-19**

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email [covid@shcc.ufl.edu](mailto:covid@shcc.ufl.edu)) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.

- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

### 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 Resource 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**: <http://www.distance.ufl.edu/student-complaint-process>.