CHEN3220 Chemical Engineering Separations - Syllabus

Spring 2022

Class Lecture 8:30-9:20 MWF A108 (first two weeks remote; zoom URL on Canvas)

Class email CHEN3220@colorado.edu

Instructors Wendy Young Wendy.Young@colorado.edu D1B20
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Office Hours (subject to change; first two weeks via zoom, URLs on Canvas)

- Instructor Review & Help after class on Mon, Wed, Fri from 9:30-10:30 in A108
- Tuesdays: 5:30-7:00 in A108
- Wednesdays: 4:00-5:30 in A108
- Thursdays: 3:00-4:30 in A115

Text *Separation Process Principles: With Applications Using Process Simulators, 4th Edition* by J. D. Seader, Ernest J. Henley, D. Keith Roper

Course Description

Studies separation methods including distillation, absorption, and extraction, and graphical and computer-based solutions to separation problems. Also studies mass transfer rate processes, including diffusion, microscopic material balances, and correlations for mass transfer coefficients. Applies mass transfer rate theory to packed and tray columns. Prereq., CHEN 3210 and CHEN 3320 or MCEN 3022.

Course Objectives

Students will be able to:

- Explain what constitutes a separation, and use the common metrics for assessing the performance of a separation process (e.g. product purity, product recovery, etc.).
- Apply concepts from mass transfer and thermodynamics to the design and analysis of transport-limited separation processes.
- Classify the major production-scale equilibrium and non-equilibrium separation methods used in industry (e.g. distillation, absorption, stripping, extraction, adsorption, membranes, and others), and explain the principles behind how each method works.
- For a specific separation need, make a preliminary choice of a separation method and predict separation performance using equilibrium data, mass balances, and energy balances.
- Predict qualitatively how changing an operating parameter or design parameter will affect separation performance.
- Utilize commercial simulation software to model difference separation systems.

Grading Breakdown

Clicker Quizzes (drop lowest 4)	10 %
Homework	20 %
Projects	20 %
Peer Reviews	10 %
Midterm Exam	20 %
Final Exam	20 %

Grading Basis

90 / 93.33 / 100 %	A-, A
80 / 83.33 / 86.67 / 89.99 %	B-, B, B+
70 / 73.33 / 76.67 / 79.99 %	C-, C, C+
60 / 63.33 / 66.67 / 69.99 %	D-, D, D+
< 60%	F

Exams

- Midterm Exam on Thursday, March 17 from 7-9pm in JSCBB (seating chart will be sent to students closer to the exam; students with 1.5x time in A104 from 6:00-9:00pm).
- Final Exam on Wed, May 4 from 7:30 pm – 10:00 pm in BIOT

Projects

Students will complete two projects, one on equilibrium separations and one on non-equilibrium separations. Details on projects will be given in class. Students may work individually or in teams of either two or three students on each project.

Teams

Students may work individually, in groups of two, or in groups of three on homework and projects. No groups of four will be allowed. It is the responsibility of every student to determine her or his team. Instructors will not determine teams, but maintain the option to reorganize teams as necessary, potentially resulting in some students working with fewer team members or on their own.

Peer-Review

Instructors determine the final allocation of points, but heavily consider peer-review input. It is extremely important that everyone contributes to important aspects of group work. Students do not want to receive poor peer reviews because they did not have a lot of responsibility – take responsibility and come through for the team! Students will be asked to turn in written peer-review assessments to the instructors regarding their team effort. It cannot be overemphasized how important it is for the team to be functional and bring out the best in all members.

Homework

Written work must be neat and readable with adequate spacing and margins; points will be deducted by TAs if they cannot read homework or find answers (box your answers!). Homework will be turned in to Gradescope either individually or in groups of 2 or 3 people.

Clickers (in-person) and Canvas Clicker Quizzes

During the first two weeks when class is remote, a clicker quiz for each class will be posted in Canvas before class starts so students can complete it during class if they wish. The quiz will stay open until midnight two days after the class so students can complete it asynchronously if they prefer. Each Canvas Clicker Quiz question is worth one point.

Once class returns to in-person clickers will be utilized during class and there will be no more Canvas Clicker Quizzes. Students must click in person themselves in A108 to receive clicker points; students cannot have someone else click for them unless it has been pre-authorized with the instructor. Each question is worth two points: one point for answering, one point for getting the correct answer.

The lowest four clicker scores will be dropped.

Late Work

If you are having difficulties, please let the instructors know *before* due dates so we can work out a solution together; we understand you have quite a few priorities and are happy to work together so reach out to us! Quiz, homework and project folders close at the stated times; no late work will be accepted except in the case of a documented emergency, a medical situation, or when it has been prearranged with the instructors.

Course Communication

All class slides, homework, and videos will be placed on Canvas for students to download.

Recording of Lectures

All lectures and instructor review/help sessions will be recorded. Class recordings will not be distributed outside the audience of students, instructors, and other class staff. Access to a recording is limited to class participants and staff through one's CU Boulder IdentiKey. Only the course instructor and staff are authorized to record a class; students are not authorized to record a class or review/help session through any means.

Student Comportment on Zoom

The instructors strongly recommend but do not require students to use their video when attending zoom lectures; being able to see one another strengthens our community. Students should mute themselves except when they are asking or answering a class question. Students are expected to present themselves as if each individual were actually in the classroom (i.e. be respectful, wear appropriate attire).

University Policies

University Policies can be found here.

Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Conduct & Conflict Resolution policies.

Requirements for COVID-19

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policy on classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus.

CU Boulder currently requires masks in classrooms and laboratories regardless of vaccination status. This requirement is a precaution to supplement CU Boulder's COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or

otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the Public Health Office (contacttracing@colorado.edu). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the Public Health Office (contacttracing@colorado.edu).

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

ANY discovered incidents of academic dishonesty will result in failure of the course and a report to the Honor Code Council. Asking another student for a helpful suggestion, or giving such a suggestion, *will not* constitute such an academic dishonesty; however, using a solutions manual, using Chegg, using uncited resources from the internet, using another group's work for the majority of a homework problem, allowing another group to use your group's work for a homework problem, clicking for someone else, having someone else click for you, or any type of cheating on an exam or project *will* be considered a dishonest act. No resubmission of work, including your own work that you turned in for a different CU, high school, or other class. Resubmission and plagiarism are grounds for failure of the class.

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the Honor Code website.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner

violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and the support resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit Don't Ignore It.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. See the campus policy regarding religious observances for full details.

CHEN 3220 Schedule – Spring 2022 (SUBJECT TO CHANGE!!!)

Look for Screencasts on topics at https://learncheme.com/screencasts/separations-mass-transfer/

Week	Monday	Wednesday	Friday
#1 1/10- 1/14	1, Intro; review of separation techniques Ch 1	2, Review of Sep Techniques & Vapor-Liquid Equilibrium (VLE) Ch 4.0-4.2	3, Aspen for VLE; K Values Ch 2.1, 2.11 (if interested, 2.2-2.10)
#2 1/17- 1/21	MLK Day – no class	4, Binary Flash Distillation Ch 4.3.0-4.3.3 Hwk #1 Due Thurs	5, Multicomponent Flash Dist Ch 4.3.4-4.3.5
#3 1/24- 1/28	6, Binary Column Dist, External Balances Ch 5.0, 5.1, 5.3, 7.0-7.2.0	7, McCabe Thiele Internal Balances Ch 7.2.1-7.2.2 Hwk #2 Due Thurs	8, Project Description & McCabe Thiele Internal Balances (cont'd)
#4 1/31- 2/4	9, Feed Stage, Partial vs Total Condensers/Reboilers Ch 7.2.3, 7.2.4, 7.3.2, 7.3.4	10, Feed Quality, Total & Minimum Reflux (i.e. Limiting Conditions) Ch 7.2.5 Hwk #3 Due Thurs	11, Multiple Feeds and Side Streams Ch 7.3, Problem 7.30
#5 2/07- 2/11	12, Enriching/Stripping Columns, Open Steam Heating, Efficiency Ch 7.4, Problem 7.26, 12.0	13, Review of Mass Transfer & Packed Column Dist Ch 7.6 Hwk #4 Due Thurs	14, Packed Column Dist (cont'd)
#6 2/14- 2/18	15, Multicomponent Distillation Ch 4.3, 9.0-9.1.1	16, Enhanced Dist & Triangular Graphs Ch 4.2, 11.0-11.1 **Project 1 Due Thurs, 2/17**	17, Enhanced Distillation (cont'd) Ch 11.2-11.7
#7 2/21- 2/25	18, Absorption Ch 4.7, 6.0-6.6	19, Absorption (cont'd) Hwk #5 Due Thurs	20, Absorption (cont'd) & Stripping
#8 2/28- 3/4	21, Packed Column Absorption Ch 6.1.2,6.7-6.9	22, Immiscible L-L Extraction Ch 5.2, 8.0-8.1, 10.1 Hwk #6 Due Thurs	23, Immiscible L-L Extraction (cont'd)
#9 3/7- 3/11	24, Leaching & Washing	25, Single Stage Partially L-L Misc Extract Ch 4.4-4.5, 8.2-8.4 Hwk #7 Due Thurs by 11:59pm	26, Multiple Stage Partially Miscible L-L Extraction
#10 3/14- 3/18	27, L-L Extraction Min Solvent Rate Hwk #8 Due **Tues by 8:00pm**	28, Review for Exam 1 **Midterm Exam on Thurs, 3/17, 7-9pm in JSCBB**	29, No class
#11 3/21-25	Spring Break – No Class	Spring Break – No Class	Spring Break – No Class
#12 3/28- 4/1	*Daisy Fuchs starts teaching* 30, Batch Distillation Ch 13	31, Batch Distillation (cont'd)	32, Crystallization
#13 4/4- 4/8	33, Drying	34, Drying (cont'd) Hwk #9 Due Thurs	35, Membranes Ch 14
#14 4/11- 4/15	36, Membranes (cont'd)	37, Membranes (cont'd) Hwk #10 Due Thurs	38, Adsorption Ch 4.8, 15.0-15.6
#15 4/18- 4/22	39, Adsorption (cont'd)	40, Adsorption (cont'd) Hwk #11 Due Thurs	41, Chromatography Ch 15.8 **Project 2 Due Sun 4/24**
#16 4/25- 4/29	42, Ion Exchange Ch 15.7	43, Review for Final Exam Hwk #12 Due Thurs	Reading Day, No Class
May	**Final Exam on Wed, May 4 from 7:30 pm – 10:00 pm in BIOT**		