ChE 363 Separation Processes Summer 2020

Instructor:	R. Bruce Eldridge
Office:	CPE 2.408
Office Hours:	Online - Time TBD
Telephone (cell):	512-633-9670
E-Mail	eldridge@che.utexas.edu

Class:	1:00-2:30 Monday-Friday
Recitation:	2:30-4:00 Tuesday

Text: *Separation Process Principles*, 4th Ed. J.D. Seader, E.J. Henley, D.K. Roper, New York: Wiley, 2016.

References: "Unit Operations of Chemical Engineering", 7th Ed. McCabe, Smith, and Harriott, New York, McGraw-Hill, 2004.

Grading basis:

Homework	20 %
Exams (2)	50 %
Final Exam	30 %

General Outline

1) Separations overview
2) Phase equilibrium
3) Mass transfer theory
4) Absorption / stripping
5) Distillation
6) Extraction
7) Adsorption
8) Membrane permeation

Goals:

Develop professional skills in the design and analysis of equilibrium-phase separation systems (absorption/stripping, distillation, extraction) and adsorption and membrane separation systems.

Provide exposure to process equipment design and operations through in-class videos.

Provide training and experiences in developing their communication skills (reading, writing, oral presentations, listening) through formal course training and class participation and exercises.

Provide training and experiences in sound problem solving approaches [define the problem and what is known, what additional information is needed, how do we obtain/measure the needed information, what techniques/procedures can be used to solve the problem, what is the best approach to obtain a good (timely, adequate accuracy, and cost effective) solution, and does this solution make sense/what is the best way to verify it.]

Provide adequate training and experiences in the use of computerized engineering tools such as process simulators and spreadsheets.

Provide learning environment that stimulates students' curiosity and interest in solving challenging engineering problems.

Provide learning environment that encourages students to "learn on their own" and feel responsible for their own career development.

Knowledge, Abilities, and Skills Students Should Have Entering This Course:

1. Ability to use and solve mass and energy balances (ChE 317).
2. Familiarity with vapor-liquid equilibrium and liquid-liquid equilibrium (ChE 322).
3. Ability to use equations of state and activity coefficient models to calculate fugacities and activity coefficients (ChE 322).
4. Ability to use Raoult's law and familiarity with partial pressures (ChE 322).
5. Ability to calculate dew points, bubble points and the ability to perform flash calculations (ChE 322).
6. Ability to access computer resources.
7. Ability to use computers to solve simultaneous algebraic equations

Knowledge, Abilities, and Skills Students Should Gain From This Course:

Thermodynamics:

1. Understand and select thermodynamic property sets for process simulators
2. Calculate bubble point, dew point, and flash calculations with simulator and spreadsheet
3. Know and use definitions of K, relative volatility, and activity coefficients
4. Know and use isotherms representations of adsorption solid / fluid equilibrium data

Mass Transfer

1. Ability to understand and use Fick's law and diffusion coefficients
2. Familiarity with analogies between correlations for heat and mass transfer coefficients
3. Use heat and mass transfer analogies and dimensionless groups to estimate mass transfer coefficients
4. Know and use film theory, penetration theory, surface renewal theory
5. Understand uni-component and equimolar diffusion
6. Understand and use two film mass transfer theory

Distillation, Absorption and Stripping

1. Understand significance of multistage, countercurrent, co-current, well mixed, and crossflow geometries
2. Understand cascades and reflux
3. Understand the concept of key components
4. Understand and estimate separation factors, number of stages, and minimum reflux
5. Find optimum reflux, feed point, preheating, and stages using graphical methods and simulators
6. Understand and use tray efficiencies
7. Select operating pressure

Gas/Liquid Contactors

1. Estimate capacity; understand flooding and entrainment
2. Select contactor type (trays, packing, sprays, bubble column)
3. Estimate pressure drop and energy requirements
4. Estimate mass transfer coefficients, and tray efficiencies

Liquid/Liquid Separations

1. Understand analogies with gas/liquid contactors
2. Select equipment for liquid/liquid contacting

Membrane Separations

1. Understand analogies to heat exchanger design
2. Estimate mass transfer coefficients for membrane modules
3. Understand permeability

Adsorption

1. Understand equilibrium capacity limits
2. Calculate breakthrough behavior
3. Develop mathematical models for adsorption processes

Process Simulation Models

1. Understand structure of process simulation models
2. Know how to construct a flowsheet using a simulator
3. Understand and use models for distillation, absorption, extraction, and membrane separations.

Impact on Subsequent Courses in Curriculum:

The material taught in ChE 363 will be used extensively in the senior design course (ChE 473K) and in the unit operations lab (ChE 264).

Course Format & Learning Activities:

- The textbook and supplemental notes provide excellent coverage of the application of separations technology methodologies. These readings are intended to provide you with some theoretical coverage of the field, but will typically emphasize the practical application of mass transfer principles.
- Lectures will complement readings from your textbook and class handouts. In general, lectures will be interactive, combining in-class discussions with small group problem solving exercises, chalk board problem analyses, etc. Open-ended questions, similar to problems you may encounter in your later engineering practice, will provide you with opportunities to enhance your problem formulation and problem solving skills. Videos on how certain pieces of equipment function will provide you with the ability to identify pieces of equipment and will also help you to link the theory with the physical.
- Recitation sections will be overseen by the TA and/or the Professor and will focus on the solution of additional relevant problems. In some cases, we will cover difficult homework problems and go

through exam solutions. In all cases, an emphasis will be placed on how a problem is approached and why a particular approach is selected.

- Regular homework assignments on the technical material will be given to provide practice applying the concepts covered in lecture. Group discussion of the homework (but not copying) is encouraged. However, it is important for exams that each student know how to independently work the assigned problems on his/her own.
- Two exams will test both retention of concepts and facts, and the ability to apply problem-solving skills. Material tested will be extracted from the readings, homework, lectures, projects, and recitations.

Performance Feedback:

Feedback on your performance throughout the semester is a key component to the learning process. In addition to feedback on homework and exams through solution sets, comments and grades, you will receive immediate input through in-class problem-solving and group activities. Feedback will also be actively encouraged through visits to me or the TA either in office hours or by appointment. However, I encourage you to attempt all problems on your own prior to seeking additional help from the TA or me.

Course Policies:

Attendance -- Attendance at lectures and recitation sessions, although not mandatory, is important for your mastery of the subject matter.

Homework & Projects --

Homework and projects must be received at the beginning of the class period in which they are due.

Homework must follow the guidelines from ChE 317: engineering paper should be used, problem statement must be defined, sources of information (Appendices, etc.) must be identified, and an arrow must point to a single boxed solution. Illegible papers or those not adhering to the criteria established in ChE 317 will not be graded. Solutions to all problems must include adequate steps, and explanations where necessary, for us to understand how you arrived at an answer. Just an equation and a final answer will not be acceptable.

Grading Policies -- Homework, quizzes, and exams will be approximately graded according to the following:

5%	Participation (making any honest attempt)
15%	Accurately defining the problem (drawing a correct schematic/interpretation of the system)
40%	Setting up the problem (making accurate assumptions, defining the correct equations, adequately explaining all steps required to reach a solution, justifying your approach)
30%	Correctness and completeness (making accurate calculations, using correct conversions, using appropriate physical properties, identifying sources of information, accurately interpreting data from tables, carrying solution to completion, using correct significant figures)
10%	Neatness, organization (logical flow), and boxing final solutions

Problems should be worked in units that are consistent with the units given in the problem statement. The final solution must be reported in units consistent with those given in the problem statement. For example, if the problem statement gives metric units, do not report your solution in English units. *Note: Conceptual errors are weighted more heavily than simple mathematical (calculation) errors.*

Late Assignments – No late assignments will be accepted without permission from Dr. Eldridge.

Grading Disputes -- Discussion on assignments should be initiated with the TA or grader, and only math errors and oversights will be considered valid reasons for dispute. If your work is not clear or the

specific question involves subjectivity, then there is no justification for re-grading. Grades will not be discussed after one week from the date the assignment is returned.

Exams --

All exams will be closed book and closed notes.

Requests for re-grading must be submitted to the professor within 1 week after the graded exam has been returned. If re-grading is desired, then the entire exam is subject to re-grading. As with assignments, if your work is not clear or the specific question involves subjectivity, then there is no justification for re-grading.

Missed Exam -- No make-up exams will be given without a written excuse for the absence.

Final Exam -- The final exam will be comprehensive and is scheduled per the final exam schedule. The location will be announced later in the semester. The date and time of the exam cannot be changed, and there will be no make-up final. Registration for this course includes the university-scheduled final exam date.

Expectations of Conduct:

We are privileged to participate in the pursuit of knowledge and truth in higher education, and students and instructors are expected to maintain an environment of respect for the course of study and one another at all times. Our classroom is a safe space for people diverse in traits and ideology to exchange ideas and grow in experience and knowledge. All students are welcome in our course, and we will respect our differences including those in gender, race, ethnicity, nationality, religion, sexual orientation, gender identity, age, culture, experience, and socio-economic background. No form of excessive teasing, discrimination, or bullying shall be tolerated at any time. Concerns about classroom environment should be addressed immediately to the instructor.

Expectations of Academic Integrity

We must respect one another's ideas by giving credit where it is due, avoiding all forms of plagiarism and cheating. Any item submitted by you and that bears your name is presumed to be your own original work that has not previously been submitted for credit in another course.

You may use words or ideas of other individuals from publications, web sites, or other sources, but **only with proper attribution**. "Proper attribution" means that you have fully identified the original source and extent of your use of the words or ideas of others that you reproduce in your work for this course, usually in the form of an endnote.

If you are not clear about the expectations for completing an assignment, be sure to seek clarification from the instructors beforehand.

Finally, you should keep in mind that as a member of the campus community, you are expected to demonstrate integrity in all of your academic endeavors and will be evaluated on your own merits. So be proud of your academic accomplishments and help to protect and promote academic integrity at the University of Texas.

Accommodation of Special Situations and Needs

If you need accommodations related to physical, psychological, or learning abilities, please speak to Dr. Eldridge after class or during office hours. If you must miss class because of religious observation, holy day, or off-site interview please speak to Dr. Eldridge after class or during office hours, at least one week prior to the absence, in order to make arrangements to submit work early. It is your responsibility to review materials outside of class on your own to make up for class time missed.