CME 415 Separation Processes

Fall 2011

University of Kentucky College of Engineering, Paducah

Lecture: 12:30PM-1:45PM TR CLC 202

Course Web Page: http://www.engr.uky.edu/~silverdl/CME415/

INSTRUCTOR:	Dr. David L. Silverstein	
	209 Crounse Hall (270) 534-3132 (Office) SilverDL@engr.uky.edu	Office Hours: Open door policy-- when I am there, I am usually available. To guarantee availability, make an appointment.
CATALOG COURSE SUMMARY:	Separations based on both equilibrium stage concepts and mass transfer rate control are addressed for a range of chemical process operations, including distillation, gas absorption, extraction, adsorption, and membrane-based processes. Design problems are conceived to require computer-aided modeling and analysis. Prereq: CME 320, engineering standing.	
TEXT:	Required: Wankat, "Separation Process Engineering Includes Mass Transfer Analysis", 3rd Ed., Prentice Hall, 2011. References: Separation Process Principles, 2nd Ed.,J.D. Seader & Ernest J. Henley, 2006; Geankopolis, "Transport Processes and Unit Operations"; McCabe, Smith, & Harriott, "Unit Operations of Chemical Engineering." These texts are either available in the library or may be borrowed on a limited basis from the instructor.	
COURSE OBJECTIVES:	This course is designed to give juniors in chemical engineering the ability to design heat exchangers, condensers, and packed columns. The fundamental principles of rate based mass transfer are discussed.	
COURSE EXPECTATIONS:	At the conclusion of this course, you should be able to: 1) Identify, analyze, and solve equilibrium and rate-based separation problems including flash, binary, and multicomponent distillation, extraction/leaching, membrane, and adsorption processes 2) Apply knowledge of separation processes to the design of equilibrium-based separations, including distillation and absorption 3) Identify and compare multiple separation strategies on the basis of mixture properties 4) Use knowledge of calculus, physics, material and energy balances, and thermodynamics to solve separation problems 5) Use modern computational tools, such as ASPEN and Excel, to analyze and design separation processes 6) Locate and utilize resources (reference books, journal articles, and internet sources) to analyze and design separation processes 7) Function effectively in teams during classroom exercises and over the course of a team design project	
COURSE POLICIES:	Attendance is expected at all lectures. Unannounced quizzes on reading or lecture material may be administered during classes. Participation in class activities is required Bring your calculators to all classes. Homework assignments will be distributed in class. No food is permitted in class. Cellular phones must be silenced and stowed during class. Homework is due within the first five minutes of the scheduled start of the period for which it is assigned. Late homework will receive no credit. Homework must be submitted on 8.5"x11" green engineering paper (except for computer printouts), one side per page. All pages should be numbered and contain your name. Multiple pages should be secured by paper clip and not folded or stapled. **Individual solutions should stand alone--** no reference to the source of the original problem should be required to understand the context and meaning of the solution you present. Each solution should contain a problem statement, a list of assumptions, a diagram (if appropriate), and a solution containing adequate steps and explanations to ensure understanding of your solution by the instructor. The final solutions to a homework problem must be boxed or otherwise distinguished from the remainder of the problem. Problems solved using a computer must contain all information required to reproduce your solution. Among other things, this means a spreadsheet printout only containing numbers is not sufficient. The formulas used must be included on the printout. All numbers must be identified and labeled with appropriate units. **You must submit the data file by email for all problems solved with**	

	computers. Homework assignments are individual tasks. No copying of solutions is permitted. You are, however, encouraged to work in small groups to discuss methods of solving the homework problems. You are, however, encouraged to work in small groups to discuss methods of solving the homework problems. Bear in mind that setting problems up is the most difficult part of most problems, and failure to practice setting problems up independently will likely result in an inability to set problems up on exams. You must indicate whom you work with on assignments completed with assistance from a group. Certain assignments may be designated group problems and must be solved as a group. Details on group problems will be provided when assigned. Any disputes regarding grading must be resolved within 5 school days of the original issuance of the grade. Requests to re-grade a problem may result in the entire assignment being re-graded and adjustments to all scores being made. This can potentially result in a decrease of score. Any grades not challenged within the five school day period are considered final. This applies to both homework and exams. Cheating is strictly forbidden, and anyone found doing so will be turned over to the University Registrar and dealt with in accordance with University policy. Working together on homework is encouraged, but each person must independently write-up their own work. Copying homework (problems, graphs, figures, computer files, etc.) between individuals is considered cheating.
EXAMINATIONS:	There will three in-class examinations and a final examination. The in-class exams will be cumulative since the previous exam. Hour exams will be closed book, closed notes, unless otherwise specified. No make-up hour exams will be given except with the advance consent of the instructor. The final exam will be comprehensive. There will be no make-up final exam. Exam dates are September 20, 2011, October 20, 2011, and November 22, 2011. These dates may be changed by mutual consent with at least one week warning. The Final Exam will last 2 hours and will begin at 10:45 AM on Thursday, December 10, 2011.
GRADING:	Final Exam: 25% Hour Exams: 45% Homework Assignments/Quizzes 10% Project Report(s) 20% A weighted grade of 90 or above is guaranteed an A, 80 or above at least a B, 70 or above at least a C, and 60 or above at least a D. A grade of E will be assigned to anyone earning a weighted grade below 60. For grades near the endpoints in the above distribution, consideration will be given to homework performance, class participation, and performance trends as a function of time. Homework and exam problems will be graded based on the following factors: correct assumptions, correct diagrams, legibility, clarity, neatness, identification of paper, clearly defined answer, correct approach to problem, and the correct answer. These criteria will be weighted according to the instructor's judgment for a particular problem. Special grading methods may apply to specific problems or problem sets as noted by the instructor.
FIRE SAFETY:	In the event of a fire, all students, faculty and staff should leave the building through the nearest exit and gather in the parking lot in front of Crounse Hall. A fire alarm should be treated as indicative of an actual fire.
INCLEMENT WEATHER:	WKCTC inclement weather policy will be followed for this class. If start of classes is delayed due to inclement weather, this class will start at regular time.

Projected Course Schedule

Period	Date	Reading Assignment
Lecture	08/16	Introduction to Separations: Ch. 1 pp. 1-10
Lecture	08/18	Flash Distillation: Ch. 2 pp. 13-30
Lecture	08/23	Ch. 2 pp. 30-54
Lecture	08/25	Column Distillation: Ch. 3 pp. 79-95
Lecture	08/30	Internal Balances: Ch. 4 pp. 101-127
Lecture	09/01	Ch. 4 pp. 127-158
Lecture	09/06	
Lecture	09/08	Multicomponent Distillation: Ch. 5 pp. 183-203
Lecture	09/13	Exact Calculation Procedures: Ch. 6 pp. 215-230
Lecture	09/15	Shortcut Methods: Ch. 7 pp. 243-257
EXAM	09/20	Chapters 1-5
Lecture	09/22	Complex Distillation: Ch. 8 pp. 265-304
Lecture	09/27	Batch Distillation: Ch. 9 pp. 329-347
Lecture	09/29	Packed Column Design: Ch. 10 pp. 357-388
Lecture	10/04	Ch. 10 pp. 388-405[TBR]
Holiday	10/06	Fall Break
Lecture	10/11	Economics and Energy: Ch. 11 pp. 419-445
Lecture	10/13	Absorption and Stripping: Ch. 12 pp. 455-484
Lecture	10/18	[AIChE Meeting, TBR]
EXAM	10/20	Chapters 6-12 [AIChE Meeting, TBR]
Lecture	10/25	Liquid-liquid Extraction: Ch. 13 pp. 499-531
Lecture	10/27	Ch. 13 pp. 531-559
Lecture	11/01	Ch. 14 pp. 575-590
Lecture	11/03	
Lecture	11/08	Mass Transfer Analysis: Ch. 15 pp. 599-656
Lecture	11/10	
Lecture	11/15	Membrane Separations: Ch. 17 pp. 725-788
Lecture	11/17	
EXAM	11/22	Chapters 13-15
Holiday	11/24	Thanksgiving
Lecture	11/29	Other Separation Methods: Ch. 18 pp. 805-892
Lecture	12/01	
Final Exam	12/10	Comprehensive Final Examination 10:45 AM - 12:45 PM

All material on this schedule is subject to change at instructor's discretion for pedagogical reasons.

Tentative Topic Summary

1) Problem solving methodology
2) Review of vapor/liquid phase equilibrium
3) Evaporation/drying
4) Flash distillation
5) Simple batch/steam distillation
6) Column distillation equipment
7) McCabe Thiele, Lewis Method, Simulators
8) Partial condensers, side streams
9) Intermediate reboilers/condensers
10) Stripping/enriching columns
11) Minimum/total reflux
12) Efficiencies
13) Multicomponent distillation
14) Complex distillation processes
15) Designing distillation columns
16) Adsorption/ion exchange
17) Extraction/leaching
18) Absorption/Stripping