RUTGERS UNIVERSITY
Department of Chemical and Biochemical Engineering

155:324 DESIGN OF SEPARATION PROCESSES (3 credits) SPRING 2014

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Class time: M Th 10:20-11:40 a.m. Class location: Wright Lab Auditorium

Other class locations: Class will meet a couple of times in the Departmental Microcomputer Lab (room C233 of SOE building) for demonstrations of the ASPEN Simulation software (dates to be determined).

Course Description:
Application of thermodynamics and mass transfer theory to the design and analysis of chemical engineering separation processes. Distillation, liquid extraction, gas absorption, and membrane separation processes. Computer software for the design and analysis of various separation processes.

Course Objectives and Outcomes: In this course, students learn how to apply knowledge of mathematics, science, and engineering to analyze and solve separations problems encountered in chemical and biochemical engineering. The course gives the student the opportunity to design single-step and multi-step separation processes, work together in multi-disciplinary/multi-functional teams, the ability to communicate their results effectively, and to use the techniques, skills, and modern engineering tools (such as process flow simulators) necessary for engineering practice.

ABET outcomes applicable to this course
(a) an ability to apply knowledge of mathematics, science and engineering
(c) an ability to design a system, component, or process to meet desired needs
(d) an ability to function in multi-disciplinary/multi-functional teams (this can be defined as a mix of biochemical and chemical engineers, or as a group of students working on a different roles of a project)
(e) an ability to identify, formulate, and solve engineering problems
(g) an ability to communicate effectively
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

TEXTBOOK (required)

P. C. Wankat, Separation Process Engineering: 3rd Edition, Prentice Hall, Upper Saddle River, NJ (2012).

TEXTBOOK (recommended)

J. D. Seader, E. J. Henley, D. K. Roper Separation Process Principles, 3rd ed., John Wiley & Sons, Inc., (2011).

PREREQUISITES

155:303 Transport Phenomena in Chemical Engineering I
155:309 Chemical Engineering Thermodynamics

SOFTWARE

Aspen Plus: This is a process simulator for chemical engineering design. This program performs material and energy balances, calculates sizes and estimates costs of equipment, and draws process flow diagrams. It has extensive thermodynamic property data bases. It is installed on all computers in the Microcomputer Laboratory (rooms C-233 & C241). To access this program, log in to one of the computers and execute the program from the Aspen Plus icon (or from Start/Programs/AspenTech/Process Modeling V8.0/Aspen Plus/Aspen Plus V8.0) or (C:\Program Files\AspenTech\Aspen Plus V8.0\GUI\Xeq\AspenPlus.exe

HOMEWORK AND GRADING POLICY

Homework problems will be assigned, collected, and graded. Homework solutions will be discussed in class the following week. No late homeworks will be accepted. There will be one midterm exam, and a final exam (or a design project). The course grade will be determined as follows:

Homework and quizzes	20%
First exam	30%
Second exam	30%
Design Project	20%

Class participation and attendance are important. There are going to be quizzes every week. One absense or the lowest quiz grade will be dropped.
Also attendance to the Professional Skills Development Course is mandatory. You can miss two without any consequence.

Academic Integrity

Students are expected to familiarize themselves with and adhere to the University policy on academic integrity at: http://academicintegrity.rutgers.edu/policy-on-academic-integrity.

It is understood that a student's name on any individual homework assignment, quiz, or exam indicates that he/she neither gave nor received unauthorized aid. On individual homework assignments, *authorized* aid includes discussing: 1) interpretation of the problem statement, 2) concepts involved in the problem, 3) approaches for solving the problem. Anything beyond this constitutes unauthorized aid and violates the academic integrity policy.

A student's name on a group assignment indicates that he/she contributed to the assignment.

Quizzes and exams are tests of individual performance. The student is not permitted to obtain assistance from any other person (or persons) during quizzes or exams. The student must adhere strictly to the instructions provided by the professor regarding what is permissible to be used during the exam. Use of computers, laptops, and cell phones is PROHIBITED during exams.

Disciplinary actions for academic misconduct will be in accord with the University policy on academic integrity.

COURSE OUTLINE

The course will follow closely the contents of the textbook. Some chapters will not be covered.
The lecture notes by Prof. Ierapatritou will be available to the students as pdf files on the Sakai web site.

Additional material may be distributed as handouts. A week-by-week schedule of the course, showing topics and reading assignments, is given below.

COURSE SCHEDULE

Week	Topic	Reading in text	Lecture notes
1	Introduction: General discussion of separation processes	Chapters 1, 2	1. Separation Processes
2	Review of vapor-liquid phase equilibria Bubble-point and dew-point calculations		2. Review of Phase Equil. 3. Bubble Point and …
3	Single-stage distillation: Boilers Flash distillation Sizing flash drums Introduction to Aspen Plus	Chapter 2	4. Single-stage distillation 5. Sizing Vertical and Horizontal Vessels
4	Multistage distillation: Cascades Towers (Columns)	Chapter 3	6. Multistage Distillation Binary Mixtures
5, 6	Binary systems: McCabe-Thiele method	Chapter 4	
7	Midterm examination (March 3)		
8	Multicomponent systems: Short-cut methods (Fenske/Underwood/Gilliland) Shortcut methods using Aspen Plus Rigorous methods (Matrix Inversion with temp. convergence) Rigorous methods using Aspen Plus	Chapter 5 Chapter 7 Chapter 6	7. Multistage Distillation Multicomp. Mixtures
9	Staged column design Packed column design	Chapter 10 (pp. 357-388) Chapter 10 (pp. 388-405)	8. Column Design I. Staged Columns II. Packed Columns
10	Economics & Energy Conservation	Chapter 11	
11	Absorption and stripping Staged operations Continuous contact	Chapter 12 Chapter 16	9. Gas Absorption I. Staged Operations II. Continuous Contact

12	Liquid-liquid extraction Immiscible systems Partially miscible systems	Chapter 13	10.Liquid-Liquid Extraction I. Immiscible Systems II. Partially Miscible
13	Rate-controlled processes Membrane separation processes Introduction Gas permeation Reverse osmosis Ultrafiltration Dialysis and Hemodialysis (Unsteady state)	Chapter 17	11. Membrane Separation Pro. I. Gas Permeation II. Reverse Osmosis III. Ultrafiltration IV. Dialysis/Hemodialysis
14	Second exam (April 28)		
15	Design project due (May 5th)		