RUTGERS UNIVERSITY
Department of Chemical and Biochemical Engineering

155:324 DESIGN OF SEPARATION PROCESSES (3 credits) **SPRING 2016**

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Class Timings: Mondays and Thursdays at 10:20-11:40 a.m.
Class Location: Wright Lab Auditorium

Other Class Lab Locations:
Classes will be held a couple of times during the semester in the following Microcomputer Labs (rooms C233, B125, & D110 of SOE building) for demonstrations of the ASPEN-Plus simulation software (see course schedule for dates). ***Please confirm computer lab assignments (which will be posted on the Sakai course webpage the week before the first lab class) before using the microcomputer labs!***

Course Description:
Application of thermodynamics and mass transfer theory to the design and analysis of chemical engineering separation processes. Example: 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, develop the ability to communicate their results effectively, and to use 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 for this course)

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

ADDITIONAL TEXTBOOK (recommended)

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

ADDITIONAL REFERENCE MATERIAL (available freely online)

C. J. King. Separation Processes, 2nd ed., McGraw Hill, Inc., (1980).

PREREQUISITES

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

SOFTWARE

Aspen Plus: This is a simulator for chemical engineering process design. This program performs material and energy balances, calculates sizes and estimates costs of equipment, and draws process flow diagrams. It has extensive thermodynamic properties database included. It is installed on all computers in the Microcomputer Laboratory (rooms C233, C241, B125, and D110). 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. ***Flashdrives with software are also available with instructor (and Kirk Tarabokia) for installation on personal laptops. Please install Aspen Plus software on your laptops as soon as possible!***

HOMEWORK AND GRADING POLICY

Homework problems will be assigned, collected, and graded on a regular basis during the semester. All homeworks will be posted on the Sakai course webpage (*please contact Prof. Chundawat or TA as soon as possible if you cannot access the Sakai course webpage!*). Students are requested to turn in their homework assignments in-class (and not by email or using Sakai, unless specifically instructed otherwise). Homework solutions will be briefly discussed in class the following week (and/or during office hours). No late homeworks will be accepted (see course schedule for dates/deadlines). There are going to be several unannounced quizzes held in class (but these will not be graded). There will be one midterm exam, one final exam, and one Aspen Plus based design project. Class participation and attendance are both important to do well in this course. The course grade will be determined as follows:

Homeworks (7 total)	35%
First exam	25%
Second exam	25%
Aspen design project	15%

TEACHING ASSISTANTS (TA) OFFICE HOURS

TA weekly office hours and location will be announced in the class and posted on the Sakai course website.

LEARNING ASSISTANTS (LA) STUDY GROUPS

LA will be holding weekly study groups for this course. Interested students are requested to enroll for study groups once instructions are posted on the Sakai course website. Limited slots are available for weekly LA study groups.

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 lecture notes, computers, laptops, and cell phones without prior authorization of instructor is **PROHIBITED** during exams.

Students caught cheating on homework assignments, projects, or exams will be immediately reported to the undergraduate program director for disciplinary action in accord with the university policy on academic integrity!

COURSE MATERIAL COPYRIGHT

All course material posted on the Sakai course website is copyrighted and may not be posted on any other web site at or outside of Rutgers without permission from the course instructor. Noncompliance with this policy will be treated as a violation of the Code of Student Conduct and will be referred to the Office of Student Conduct for action.

COURSE OUTLINE & SCHEDULE

The course will follow closely the contents of the required textbook by Wankat (W). Some chapters will not be covered. Additional reading will be assigned from other textbooks like Seader (S), which maybe posted on the Sakai course website. Required reading of chapters from either textbook will be indicated in the course outline below (e.g., Chapter 1 from Wankat's book and Seader's book will be designated as W1 and S1, respectively). Partially complete lecture slides by Prof. Chundawat will be available to the students as pdf files on the Sakai web site. **Students will be expected to complete lecture notes in class.** Additional material may be distributed as handouts in-class. A week-by-week schedule of the course, lecture topics, textbook reading assignments, homework deadlines, Aspen labs, and relevant lecture description is given below *(please follow announcements on the Sakai course webpage for any changes to the following schedule!)*. **Students are advised to complete reading assignments prior to attending the lecture to keep up with the class.**

Week	Date	Location	Lecture Topic	Description	Assigned Reading	HW Problem Set Deadlines
Week 1	21-Jan	WL-AUD	Introduction	1. General discussion of separation processes	S1	#1 Set Available
Week 2	25-Jan	WL-AUD	Review of Basic Concepts	2. Vapor-liquid phase equilibria	S2	
	28-Jan	WL-AUD	Review of Basic Concepts	3. Bubble-point and dew-point calculations	S4 (pp. 139-150)	
Week 3	1-Feb	WL-AUD	Single Stage Distillation	4. Introduction to Flash drum distillation (binary systems)	W2	#1 Set Due, #2 Set Available
	4-Feb	WL-AUD	Single Stage Distillation	5. Flash drum distillation (multicomponent systems)	W2	Aspen Handout: Flash (Lab 1)
Week 4	8-Feb	**TBA***	Single Stage Distillation	**6. In Lab Training: Aspen-Plus Simulator Software 101**	Aspen Lab 1	
	11-Feb	WL-AUD	Multi-Stage Distillation	7. Introduction to column distillation for binary systems	W3	#2 Set Due, #3 Set Available
Week 5	15-Feb	WL-AUD	Multi-Stage Distillation	8. Column distillation & stage-by-stage method (contd)	W3, W4	HW #3 requires Aspen Lab 2
	18-Feb	WL-AUD	Multi-Stage Distillation	9. Column distillation & McCabe-Thiele method	W4	
Week 6	22-Feb	WL-AUD	Multi-Stage Distillation	10. Column distillation & McCabe-Thiele method (contd)	W4	#3 Set Due, #4 Set Available
	25-Feb	WL-AUD	Multi-Stage Distillation	11. Introduction to multi-component column distillation	W5	
Week 7	29-Feb	WL-AUD	Multi-Stage Distillation	12. Multi-component distillation & Short-cut methods (contd)	W7	
	3-Mar	WL-AUD	Multi-Stage Distillation	13. Multi-component distillation & Rigorous methods (contd)	W6	#4 Set Due
Week 8	7-Mar	WL-AUD	Exam Review	**14. Mid-term Review & In-class Problem Solving Session**		
	10-Mar	WL-AUD	**Mid-term Exam 1**			
Week 9	14-Mar	WL-AUD	*Spring Break - no class*			
	17-Mar	WL-AUD	*Spring Break - no class*			
Week 10	21-Mar	WL-AUD	Multi-Stage Distillation	**15. Mid-term Exam Discussion**		#5 Set Available
	24-Mar	WL-AUD	Multi-Stage Distillation	16. Staged and Packed Column Design	W10	
Week 11	28-Mar	WL-AUD	Multi-Stage Distillation	17. Column Design (contd) and Distillation Economics	W10, W11	
	31-Mar	WL-AUD	Multi-Stage Distillation	18. In-class Tutorial: DSTWU/RADFRAC Aspen Simulation	Aspen Lab 3	#5 Set Due
Week 12	4-Apr	**TBA***	Multi-Stage Distillation	**19. In Lab Training: Aspen simulations of multi-stage distillation**	Aspen Project	
	7-Apr	WL-AUD	Gas Absorption	20. Gas Absorption: Staged Column Operations	W12	#6 Set Available
Week 13	11-Apr	**TBA***	Multi-Stage Distillation	**21. In Lab Training: Aspen simulations of multi-stage distillation**	Aspen Project	
	14-Apr	WL-AUD	Gas Absorption	22. Gas Absorption: Packed Column Operations	S6, W16	
Week 14	18-Apr	WL-AUD	Liquid-Liquid Extraction	23. Liquid-Liquid Extraction: Immiscible Systems	W13	#6 Set Due, #7 Set Available
	21-Apr	WL-AUD	Liquid-Liquid Extraction	24. Liquid-Liquid Extraction: Partially Miscible Systems	W13	
Week 15	25-Apr	WL-AUD	Membrane Separations	25. Membrane Separations: Gas Permeation	W17	
	28-Apr	WL-AUD	Membrane Separations	26. Membrane Separations: Reverse Osmosis	W17	#7 Set Due
Week 16	2-May	WL-AUD	Unsteady State Operations	27. Adsorption & Chromatography; **Final Exam Review**	W18	Final Aspen Lab Report Due
Week 17	9-May	WL-AUD	**Finals-Week Exam 2**			

TBA* or "to be announced" in class earlier in the semester
WL-AUD is Wright Rieman Lab Auditorium