CHE 597C – Membrane Separations and Transport

Fall 2014

Classes: Mon, Wed & Fri, 11:15 PM – 12:05 PM, Thomas 222

Course Website: www.angel.psu.edu

Instructor: Manish Kumar, manish.kumar@psu.edu, 155 Fenske Lab, 865-7519
Office hours: Walk in anytime available (door open and not in a meeting)

Required Text: **None required, Hand written lecture notes will be posted (organized according to course outline), other materials will also be posted**

Recommended Texts:

Diffusion - Mass Transfer in Fluid Systems ***(most used in course)***
E.L. Cussler, 1997

Membrane Technology and Applications
Richard W. Baker, John Wiley & Sons (2004)

Microfiltration and Ultrafiltration
Zyndey and Zeman, CRC Press, 1996

Membrane Handbook
Ho and Sirkar (editors), 1992

Microfiltration and Ultrafiltration Handbook
Cheryan, 1998

Software: Matlab and/or Mathematica might be useful in solving some problem sets.

Course Objectives:

The overall objective of this course is to provide students a solid background in the principles, applications and practice of membrane technology. By the end of the course students will be able to:

1. Understand the physical parameters governing mass transfer in membrane systems
2. Identify the relevant properties of mixtures that can lead to appropriate choice of membrane for effecting separations. Understand the relevant design parameters of each membrane process.
3. Perform design and scale-up calculations for membrane processes
4. Understand the experimental data required to design and scale-up a membrane process. Provide a general experimental strategy for obtaining such data

Approximate Course Grading Outline

Homework Assignments: (4-5) ~ 25%

Problem sets are primarily to be used as study tools, reflecting the types of questions that will show up on the exams, but may be more time consuming. Attempting to solve the problem sets in a timely manner will help you to identify topics you are not clear on. They will be due on Fridays. You can work with other students and names of your collaborators should be on the answer sheet but **everybody needs to hand in individual HWs**.

Exams:	Midterm Exam	~ 25%
	Final Project	~50%

The date and time for the exam need to be confirmed and room locations determined. Firm times and locations will be announced in class and via Angel mail. I am considering conducting an in-class or take-home exam.

Comments:

Late assignments will not be accepted since homework solutions will be made available after class period in which assignments are due. Please do not hesitate to ask for additional clarification on these policies at any time during the semester.

Course Outline

The course is loosely organized into 4 functional units.

Unit 1 Fundamentals of Diffusion
Unit 2 Traditional Classes of Membranes
Unit 3 Fundamentals of Mass Transfer
Unit 4 Systems Design and Emerging Applications

I. Tentative Lecture Schedule

Subject	Lecture	Date	Topic	References
	1	8/25	Introduction	
Diffusion	2	8/27	Thin Film	
	3	8/29	Infinite Slab	
	4	09/3	Unsteady Film	
	5	09/05	Generalized Mass Balance	
	6	09/08	Concentrated Diffusion	HW1

	7	09/10	~~Maxwell-Stefan Equations~~	
	8	09/12	Heuristic for Diffusion	
	9	09/15	Diffusion in Polymers	
Membranes	10	09/17	Dense Membranes-Gas	
	11	09/19	Applications	
	12	09/22	Chemistry of better membranes	
	13	09/24	Porous Membranes-Gas	
	14	09/26	Mixed Matrix Membranes	
	15	09/29	Porous Membranes-Liquid flow	
	16	10/01	Hindered diffusion	
	17	10/03	Applications	HW2
	18	10/06	Dense Membranes-Liquid Π	
	19	10/08	Reverse Osmosis	
	20	10/10	Membrane fabrication	
	21	10/13	Membrane characterization	
Mass Transfer	22	10/15	Mass Transfer Coefficients	
	23	10/17	Alternative Definitions	Exam
	24	10/20	Film, Penetration, Stupid Theory	
	25	10/22	Boundary Layer Theory	
	26	10/24	Graetz-Nusselt Theory	
	27	10/27	Overall Mass Transfer	
	28	10/29	Energy Use and System Design	
	29	10/31	Electrical Potential Driving Force	HW3
	30	11/03	Electrical Potential Driving Force	
Systems	31	11/05	Chemical Potential Driving Force	
	32	11/07	Chemical Potential Driving Force	
	33	11/10	Biological and Biomimetic	
	34	11/12	Biological and Biomimetic	
	35	11/14	Biological and Biomimetic	
	36	12/01	Biological and Biomimetic	HW4
	37	12/03	Report Presentation	
	38	12/05	Report Presentation	
	39	12/08	Report Presentation	
	40	12/10	Report Presentation	
	41	12/12	Report Presentation	