Chemical Engineering 210 (section A)
Material and Energy Balances
Fall 2009

Instructor: I.C. Schneider, 3053 Sweeney Hall, (515) 294-0450, ians@iastate.edu

Lecture: MWF 10:00-10:50

Office Hours: WR 1:00-3:00

Prerequisites: Chem 178 (general chemistry), Math 166 (integral calculus)

Text and Materials: Felder and Rousseau, *Elementary Principles of Chemical Processes*, Wiley (2005).

Course Description: This course is the first chemical engineering course offered and is an introduction into how chemical engineers think and how they solve problems. Simply stated, chemical engineers seek to gather just the right amount of quantitative information in order to understand and control a chemical system. Information from the physical, chemical and biological sciences will be used in combination with mathematics to analyze and design systems that chemical engineers often encounter. This first course introduces students to chemical engineering careers, teaches students about different chemical engineering processes and strengthens the student's ability to convert physical/chemical properties between systems of units. However, the paramount goal of the course is to teach students how to analyze and design various types of systems by balancing both mass and energy. The most effective vehicle for this is problem solving. Chemical engineers work and impact various industries ranging from traditional chemical industries all the way to biotechnological or medical industries. Consequently, problems will range from performing mass and energy balances on hydrocarbon combustion all the way to performing mass and energy balances over an individual cell in order to understand disease progression and design proper therapeutics.

Grading:

Exam I	15%
Exam II	15%
Exam III	15%
Home Problems	20%
Design Project	15%
Final Exam	20%

If you feel that the grade you received for homework or an exam was incorrect or unfair, submit to me a typed 1 page document outlining the reason why you think the grade to be incorrect or unfair. I will evaluate the request and regrade the entire homework or exam, not solely the section in question.

Homework: Homework will be assigned in groups of three or four, usually on Monday and will be due on Friday by the end of class. You are expected to hand in one copy from each group on time. The homework should be hand written on engineering paper and should be neat and easy to follow. An example homework format is given on the WebCT page. Any homework that deviates from this example will lose points. Units are an important part of the material in this course as well as any other chemical engineering course. Answers that do not contain units carried out through the entire calculation will lose points. Late homework will not be accepted unless there is a good reason and I

approve of it before the homework is due. Groups are intended to facilitate learning, not hinder it. You are not a company, so delegation of problems is not constructive and everyone is expected to contribute equally to the homework even though one copy is submitted. You are free to consult members of your homework group, the text, class notes or me without reference. Any other sources must be referenced. Handing in virtual copies of solutions of the same homework problems from previous course offerings or other student groups is plagiarism and is not permitted. Some homework will be assigned individually and will be completed via the internet on Sapling.com. More information will follow regarding this.

Exams: Exams will be closed book. I will only answer questions about the exams during the class hour, so that everyone has the benefit of hearing them. Makeup exams will not be given.

Design Problem: There will be a design problem due at the end of the semester and the problem will be solved in groups of three or four. Any books or online references can be consulted, but must be properly referenced. ***No person*** outside of those in the group, except me can be consulted on ***specific*** design questions.

Expectations and Academic Honesty: I expect you to show up on time to class and remain in class until dismissed. Any absences from class should be brought to my attention at least one day before, barring family emergencies or illnesses. With the assumed prevalence of N1H1 flu, if you are running a fever, please stay at home and do not come and expose the me or the rest of your classmates. A portion of the lectures will include class exercises, so please bring your book to class. Turn off your cell phones before class and cell phone use during class will not tolerated.

Both the University and Departmental Student Handbooks and the University Catalog contain policy statements with which you should be familiar. Simply stated, anything you turn in under your name is to be your work and not that of others. If others have contributed (knowingly or unknowingly) to your work, they need to be referenced.

Course Objectives:

1. Convert a quantity expressed in one set of units into its equivalent in any other dimensionally consistent units using conversion factor tables.

2. Explain in your own words the meaning of the following terms used to describe processes: batch, semibatch, continuous, transient and steady-state.

3. Formulate mass and energy balances for steady-state and transient processes.

4. Solve mass and energy balance equations using different types of information provided to you.

5. Perform pressure, temperature, volume calculations for ideal and non-ideal gases.

6. Perform vapor-liquid equilibrium calculations for systems containing on condensable component and for ideal multi-component solutions.

7. Calculate internal energy and enthalpy changes for process fluids undergoing specified changes in temperature, pressure, phase and chemical composition.

8. Describe what chemical engineers do and whether this appeals to you.

Course Outline:

Date	Topic	Readings	Problems
Aug 24	Policies, Objectives, Introduction, Units	Ch1.0-2.3	
26	Units and Calculations	2.4-2.8	
28	Processes and Process Variables	3.0-3.3	HW1
31	Processes and Process Variables	3.4-3.6	
Sept 2	Introduction to Material Balances	4.0-4.2	
4	Material Balance Calculations	4.3	HW2
7	***Labor Day***		
9	Balances on Multiple Unit Processes	4.4	
11	Recycle and Bypass	4.5	HW3
14	Chemical Reaction Stoichiometry	4.6	
16	Review for Exam I		
18	**Exam I**		
21	Balances on Reactive Systems	4.7	
23	Combustion	4.8-4.10	
25	Liquid/Solid Densities and Ideal Gases	5.0-5.2	HW4
28	Non-ideal Gases	5.3	
30	Compressibility	5.4-5.5	
Oct 2	Single Component Phase Equilibria	6.0-6.1	HW5
5	Gibbs Phase Rule, One-Condensible Component Systems	6.2-6.3	
7	Multicomponent Systems	6.4	
9	Solution of Solids in Liquids	6.5	HW6
12	Two-phase Equilibria	6.6-6.8	
14	Review for Exam II		
16	**Exam II**		
19	Energy Forms and Energy Balances on Closed Systems	7.0-7.3	
21	Energy Balances on Open Systems	7.4-7.5	
23	Energy Balances on Open Systems	7.4-7.5	HW7
26	Energy Balances	7.6	
28	Mechanical Energy Balances	7.7-7.8	
30	Balances with Pressure Changes	8.0-8.2	HW8
Nov 2	Changes in Temperature	8.3	
4	Phase Change Operations	8.4	
6	**Design Problem**		HW9
9	Mixing and Solution	8.5-8.6	
11	Review for Exam III		
13	**Exam III**		
16	Heats of Reaction	9.0-9.3	
18	Heats of Combustion	9.4	
20	Energy Balances on Reactive Processes	9.5	HW10
23	***Thanksgiving Break***		
25	***Thanksgiving Break***		
27	***Thanksgiving Break***		
30	Fuels and Combustion	9.6-9.7	
Dec 2	General Transient Balances	11.0-11.1	
4	Transient Material Balances	11.2	HW11
7	Review for Final Exam		
9	Review for Final Exam		
11	Review for Final Exam		Design Problem
17	**Final Exam (Thursday, tentative)**	9:45 -11:45	