155: 201 Chemical Engineering Analysis I Fall 2011

Web page: Sakai webpage

Lectures: Tue, Fri 8:40-10:00am, SEC 117

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Course Description: Chemical Engineering Analysis I introduces concepts and methods of fundamental importance to subsequent courses in the chemical engineering major and to the practicing chemical engineer. We will focus on two key principles: 1) the conservation of mass, and 2) the conservation of energy. Application of these two principles is essential in the design and analysis of chemical engineering systems. We will first consider basic units, variables and conceptual representations used to describe chemical processes. We will then apply the conservation of mass to chemical systems in the form of mass balances. The study of mass balances will include systems in which chemical reactions are occurring as well as systems containing multiple phases (gas, liquid, solid) at thermodynamic equilibrium. Finally, we will incorporate the conservation of energy in the form of energy balances to analyze chemical systems undergoing heating, chemical reaction and/or phase change.

Course Objectives:

1. Develop the ability to identify and solve chemical engineering problems based on written information.
2. Understand and use process flowcharts in problem solving.
3. Understand, derive and solve steady-state material and energy balance equations.
4. Apply the following concepts within the context of material and energy balance problems:
    a. Reactive systems – limiting and excess reactants, fractional conversion, extent of reaction, yield and selectivity, combustion
    b. Recycle, purge
    c. Single-component phase equilibrium – vapor pressure, boiling point, triple point
    d. Gas-liquid systems – Raoult's Law, Henry's Law, saturation, humidity, phase diagrams, bubble point, dew point
    e. Thermodynamic concepts – enthalpy, heat capacity, internal energy, adiabatic, isothermal, heats of reaction

Textbooks:

Felder, R.M. and Rousseau, R.W. 2005. **Elementary Principles of Chemical Processes, 3rd Ed**. John Wiley & Sons, NY. ISBN 978-0-471-72063-8

Software:

Microsoft Excel will be used for spreadsheet calculations in some homework problems. Matlab may also be used for matrix manipulations. It is installed on all PCs in the Microcomputer Lab (room C233).

Class Participation:

Class attendance and participation is important and expected from all students.

Assessment: *Homework: 30%, Quizzes: 10%, Exams (3): 60%.*

Course Context:

Week	Date	Topic	Reading Assignment	HW & Quizzes
1	Sep 2	Syllabus, Policies, Assessment Quiz	Syllabus	
2	Sep 6	Engineering Calculations, Process Variables	Ch 2-3	
	Sep 9	Fundamentals of Material Balances *(AIChE presentation)*	Ch 4.1-4.3	Q1
3	Sep 13	*Professors Ramachandran and Chiew*		
	Sep 16	Fundamentals of Material Balances	Ch. 4.1-4.3	HW 1
4	Sep 20	Material Balances: Multiple-Unit Processes	Ch. 4.4	Q2
	Sep 23	Material Balances: Multiple-Unit Processes	Ch. 4.4-4.5	HW 2
5	Sep 27	Material Balances: Reactive Systems	Ch. 4.6-4.7	Q3
	Sep 30	Material Balances: Reactive &Combustion Systems (*covered by the TA)*	Ch. 4.6-4.7-4.8	HW 3
6	Oct 4	*Professors Sofou, Moghe, and Futran*		
	Oct 7	Material Balances:Review		
7	**Oct 11**	**EXAM I**		
	Oct 14	Single-Phase Systems: Ideal Gases	Ch. 5.1–5.3	
8	Oct 18	Multiphase Systems: Single Component Gas-Liquid *(Covered by TA)*	Ch. 6.1-6.3	HW4
	Oct 21	*Professors Roth, Asefa and Shapley*		
9	Oct 25	Multiphase Systems: Multicomponent Gas-Liquid	Ch. 6.4	Q4
	Oct 28	Multiphase Systems: Multicomponent Gas-Liquid	Ch. 6.4	HW 5
10	**Nov 1**	**EXAM II**		
	Nov 4	Fundamentals of Energy Balances	Ch. 7.1-7.4	
11	Nov 8	Energy Balances: Thermodynamic Data Tables	Ch. 7.5	Q5
	Nov 11	Balances on Nonreactive Processes	Ch. 8.1-8.3	HW 6
12	Nov 15	Energy Balances: 1-Phase, Nonreactive Systems	Ch. 8.3	Q6
	Nov 18	Energy Balances: Phase Change Operations	Ch. 8.4	HW 7
13	Nov 22	NO CLASS – HAPPY THANKSGIVING		
	Nov 25	NO CLASS – HAPPY THANKSGIVING		
14	Nov 29	Balances on Reactive Processes	Ch. 9.1-9.3	Q7
	Dec 2	Balances on Reactive Processes	Ch. 9.4-9.5	HW 8
15	Dec 6	Balances on Reactive Processes	Ch. 9.4-9.5	Q8
	Dec 9	Problem Solving	Ch 8-9	HW9
16	**Dec 13**	**EXAM III**		

ABET Outcomes and Assessment:

Program Outcomes

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(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
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Mapping of content in program core curriculum to program outcomes. Highlighted entries represent the highest weighted assessment points

Outcome Course	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
155:201	✓		✓		✓	✓	✓		✓		✓
:208	✓				✓						✓
:303	✓	✓		✓	✓	✓					✓
:304	✓	✓		✓	✓	✓					✓
:307	✓	✓			✓	✓			✓		✓
:324	✓	✓	✓	✓	✓		✓		✓		✓
440:407	✓				✓				✓	✓	
155:409	✓				✓	✓					✓
:411	✓		✓		✓						✓
:415	✓	✓		✓			✓	✓			✓
:416	✓	✓		✓			✓	✓			✓
:422	✓				✓		✓				✓
:427	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
:428	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
:441	✓	✓	✓		✓						✓
:491,492									✓		
societies							✓		✓	✓	

Societies: student professional organizations include AIChE, ISPE, SWE, OXE

The achievement of outcomes (a), (e), and (k) will be assessed in this course as follows:

Main outcomes

Outcome (a): an ability to apply knowledge of mathematics, science and engineering

(1) Assessment test: 1st day of class – same test later in the semester.

(2) Exams – Homeworks : Most of the problems test the ability to apply knowledge of mathematics, science and engineering in problem solving

Outcome (e): an ability to identify, formulate, and solve engineering problems

Homeworks – The problems will require the formulation of the problem described, identification of the main challenges, investigation of multiple solution approaches, report of the alternatives.

Outcome (k): an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Homework assignments will require the use of Excel and Matlab as software to perform calculations. The evaluation of the use of this tool will be tabulated for the whole class and additional sessions will be scheduled as appropriate.

Other outcomes

Outcome (c): an ability to design a system, component, or process to meet desired needs

Outcome (f): an understanding of professional and ethical responsibility

Outcome (g): an ability to communicate effectively

Outcome (i): a knowledge of contemporary issues

POLICIES AND PROCEDURES

Academic Integrity

Students are expected to familiarize themselves with and adhere to the University policy on academic integrity at: http://academicintegrity.rutgers.edu/integrity.shtml. 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. Disciplinary actions for academic misconduct will be in accord with the University policy on academic integrity. At a minimum, a first offense will result in a zero for the assignment, and may be more severe. The penalty for repeat offenses will be significantly more severe. A third offense will result in a failing grade for the course.

Homework

The first several homework assignments will be completed individually. After that, homework assignments will be completed in teams of 3-4, as assigned by the instructor. Detailed policies for teamwork will be provided. Peer evaluation by teammates will be one factor in determining individual grades for group homework assignments. Homework assignments will be posted online one week in advance of the due date.

Homework Format

See instructions posted at the course website.

Late Homework

Homework is due at the beginning of the class period on the date it is due. Any assignments turned in after lecture has begun will be considered late. Late homework will receive a maximum grade of 60%, and will be accepted up to one class period following the due date. However, each individual or group is limited to a maximum of two late assignments.

Quizzes

Most weeks, a short quiz will be given on material covered during the previous week.

Exams

There will be three exams during the semester and no final exam. Exams 1 and 2 will be closed book while Exam 3 will be open book. All exams will be closed notes. Exam problems will be similar to homework problems and quizzes.

Attendance

Attendance in class is important and expected.

Solutions to Homework, Quizzes, and Exams

Solutions to homework, quizzes and exams will not be posted. Final answers will be given to provide you with a point of comparison, and we may work through some problem in class, but you are responsible for asking enough questions in class and during office hours to make sure you understand how to solve the problem.

Absence from Quizzes

No make-up quizzes will be given. However, with prior instructor approval for an excused absence, students may miss one quiz. In this case, their quiz grade will be calculated on the basis of the quizzes taken. If a student misses more than one quiz, or does not obtain prior instructor approval, or the absence is not excused, he/she will receive a grade of zero for the missed quiz.

Absence from Exams

Absence from an exam will be excused only in the case of certified medical emergencies. Other situations, though they may be serious, will not be accepted as a reason to miss an exam, and a make-up exam will not be given.

Grading

Assignments and quizzes will be graded by the TA, and the exams by the instructor. If you believe that an error has been made in grading your work, bring it to the TA/instructor during his office hours.

Grading Policy

A final course grade will be assigned on the basis of your numerical grades earned on assignments, quizzes, and exams, with the following weighted distribution of points:

Exams (3)	60%
Homework	30%
Quizzes	10%
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TOTAL	100%