CBE 140: Intro. to Chemical Process Analysis – Fall 2014
Course Information

Class Instructor: Dr. Paul F. Bryan
Office: 221 Gilman (usually MWF mornings only)
Phone: (510) 642-4398 (shared line / voice mail not checked regularly)
Email: pfbryan@berkeley.edu (most reliable means of contact)
Office Hours: Mon./Fri. 9:15 – Noon

Graduate Student Instructors:

Carly Anderson	Nahyun "Nacho" Cho	Sabrina Sun
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Mon. 3:30 – 5:30 PM*	Tue. 3:30 – 5:30 PM*	Tue. 6:00 – 8:00 PM
211 Gilman Hall	201 Hildebrand Hall	TBA / Bixby N/S**

* Building doors may be locked at 5:00 PM, especially for Gilman Hall
** Room location to be confirmed; Bixby N/S are accessible in the evening hours

Lecture: M/W/F 8:00 – 9:00 AM (120 Latimer Hall)

Discussion Sections: As published / Final list to be determined / announced

Class Website: https://bcourses.berkeley.edu/courses/1267729

Course Description

Introduction to analysis, design, study, and practice of chemical engineering. Students will learn to analyze chemical and physical processes using conservation of material and energy within multi-unit systems. Concepts of control volume, mass conservation, flow basis, atom balances, and energy conservation in open and closed systems are applied under steady-state operation. The relationship of the course material to future courses in the CBE curriculum and to professional practice will be discussed.

Prerequisite Knowledge and/or Skills

- Introductory college chemistry: chemical reactions – balances, rates & equilibrium; molecular stoichiometry & structure; behavior of ideal gases.
- Mathematical ability to solve simultaneous linear equations and non-linear equations in one variable. Knowledge of elementary algebra and functions and elementary differential and integral calculus.
- Introductory college physics: understanding of force / velocity relationship, solid and fluid mechanics, and forms and transformation of energy.
- Computer skills for graphics, calculations, and accessing information.

Course Prerequisite(s)

- Physics for Scientists and Engineers (Physics 7A & 7B)*,**
  (* Physics 7B concurrent OK) (** Requires Math 1A, 1B & 53)

- General Chemistry and Quantitative Analysis (Chem 4B)*
  (* Chem 4B concurrent with consent of Instructor)

Course Objectives and Outcomes

- Objectives – the students learn:

  - How to analyze and fit equations to experimental data
  - How to set control volumes and perform steady-state mass balances for complex chemical processes with and without multiple chemical reactions
  - The criteria for chemical reaction and phase equilibria and how to apply those criteria to equilibrium conversion and phase-separation behavior
  - The concepts of energy, work, heat, and heat transfer in open and closed systems in the context of the first law of thermodynamics
  - How to set control volumes and perform steady-state energy balances for simple processes with and without chemical reactions
  - The behavior of continuous stirred tank, batch, and plug-flow reactors
  - The equilibrium stage and its role in separation processes
  - Basics of operation of common industrial unit operations
  - Fundamentals of key traditional and emerging industries where chemical engineers play an important role
  - The scope of core chemical engineering principles, and how this course and core science and math relate to the curriculum as a whole

- Outcomes – Students must be able to:

  - Analyze mass and energy conservation in complex chemical processes, including recycle and purge;
  - Solve simultaneous mass and energy balances in chemical processes.
  - Use tabulated and/or graphical representation of thermodynamic data to analyze and design processes;
  - Distinguish between open, steady-state and closed transient forms of mass and energy conservation;
  - Analyze simple multistage separation processes in co-current and countercurrent operation;
  - Solve mass balances for batch stirred-tank reactor (BSTR), continuous stirred-tank reactors (CSTR), and plug-flow reactors (PFR);

Course Structure

There will be three lectures and one discussion section per week, where all students are expected to attend and participate regularly. There will be homework assignments, unannounced quizzes, two midterm examinations, and a final examination.

Homework assignments will focus on analysis and solution of engineering problems. Solution strategies will be discussed in lecture, and some examples will be worked. Students will be asked to contribute to the working of problems and to other classroom discussions. In the discussion section, some homework problems will be reviewed from the previous week, and some additional examples will be worked relevant to the current week's material. Homework will be assigned each Wednesday and due by the end of lecture in class the following Wednesday. Homework submitted to the GSI's after that time will not be graded and will not receive any credit. For each student, the lowest HW grade of the semester will be dropped.

Some homework problems will require the use of Matlab. Links to tutorial information will be provided, and basics will be covered in class. Students have low-cost access to Matlab for their personal computers, and it is also installed on the computers in 175 Tan Hall and other campus computing facilities. Chemical engineers routinely use computer tools for basic mathematics (e.g., Excel), more involved mathematics (e.g., Matlab), solution of the systems of differential equations that arise in the modeling of heat and mass transfer and fluid flow (e.g., Comsol), and simulation of multi-unit chemical processes (e.g., ASPEN Plus). In this course you will begin / continue to make these part of your chemical engineering "toolbox."

Lectures will also cover "descriptive" material related to core knowledge of the Study and Practice of Chemical Engineering. Some of this material will be related to CBE 140 problems, some will provide an introduction to material to be addressed in more detail in future courses, and some will provide a background for students' career choices and eventual professional practice of chemical engineering.

In order to encourage reading the text material in advance, as well as class attendance, unannounced quizzes will be given occasionally. These will typically be closed-book and will not require calculations. Once the quizzes have been handed out, no late arrivals will be allowed to participate. The midterms and the final will be part closed book, part open-book / open-note and will require set-up and solution of problems as well as discussion / explanation ("essay") type responses. Calculators will be allowed, but no devices with internet / cellular connectivity or substantial document-storage capability will be permitted (e.g., laptops, tablets, smartphones, etc.).

Textbook: Felder, R. M. and R. W. Rousseau, *"Elementary Principles of Chemical Processes,"* 3rd Ed., John Wiley & Sons (2005)

Chapters 1-10 will be covered, plus supplementary material and one or more special projects

Grading (out of 1,000 points total)

Classroom Participation	100	(attendance, contributions to discussion)
Homework	200	(incl. Matlab and possibly special projects)
Quizzes (~5 Total)	100	
Midterms	300	(150 pts each)
Final Examination	300	
TOTAL	1000*	

(* students may occasionally receive small amounts of extra credit for exceptional performance or contributions to the educational process, but all final grades will be based on a 1,000-point total)

Schedule:

Week	Week of	Material Covered / Exams / Etc.
1	8/29/14	Introduction / Chap 1
2	9/08/14	Chap 2
3	9/15/14	Chap 3
4	9/22/14	Chap 4
5	9/29/14	Chaps 4 & 5
6	10/06/14	Chap 5 (Midterm through Chap. 4)
7	10/13/14	Chaps 5 & 6
8	10/20/14	Chap 6
9	10/27/14	Chap 7
10	11/03/14	Chap 7
11	11/10/14	Chap 8 (Midterm through Chap 7)
12	11/17/14	Chap 8
13	11/24/14	Chap 9
14	12/01/14	Chap 9 / Review
15	12/08/14	R & R & R Week
16	12/15/14	Finals Week – Final 12/15/14 – 7-10 PM

(Chap. 1 material will also be supplemented & distributed throughout the course)
(Please advise instructor immediately of any Midterm-week conflicts)