Material and Energy Balances (CHE 2215) Fall 2014

Lectures: Monday, Wednesday, and Friday 1:00-1:50 PM in ChemE 005
Problem Session: Thursday 5:00-5:50 PM in ChemE 005

Instructor: Gary Koenig, email: gary.koenig@virginia.edu, office: ChemE 114 (near ChemE department office)
Instructor Office Hours: Wednesdays 9:00-11:30 AM, Thursdays 9:30-10:55 AM in Prof. Koenig's office

TA: Ethan Paharik (eap2qf@virginia.edu)
Teaching Assistant Office Hours: Wednesdays 2-4 PM and Thursdays 2-4 PM at Wilsdorf hallway whiteboards or in ChemE 317 (the TA's office)

Final Exam: Saturday, December 13th 9 AM- 12 PM in CHE 005

Course Description: How can you estimate the release of pollutants from a coal-fired power plant and how changes to processes within the plant might influence the amount released to the environment? If a bench-scale drug compound is showing promising results, how do you start to think about producing enough to treat millions of people? Chemical engineers are challenged with similar questions across a wide variety of fields and applications including petroleum refining, pharmaceuticals, polymers, consumer products, water purification, food science, and commodity and specialty chemicals. In designing the processes to support these various needs, chemical engineers need to consider the operations involved, the amounts of raw materials that are required, separations of more and less valuable materials, and energy requirements. In this course you will be introduced to how to start to evaluate and estimate the necessary components of a chemical process as chemical engineers. The decisions related to chemical processes can have profound economic, environmental, and even political consequences.

Course Objectives: The objectives of this course are for students to learn to:
(1) Recognize the value of chemical technology through being introduced to the field of chemical engineering.
(2) Create representative process flow diagrams and use them to organize systems of equations.
(3) Formulate material balances to solve for compositions and flow rates of process streams.
(4) Incorporate single and multiple reactions into unit operations within chemical processes.
(5) Identify and calculate physical and chemical properties for compounds and approaches to estimate these values for chemical processes.
(6) Derive energy balances for chemical processes and integrate with material balance calculations to solve for energy inputs and/or outputs.
(7) Collaborate effectively on a team project integrating multiple chemical processes.

Course Assessment:

Quizzes (45%)
Three quizzes will be given in-class which each account for 15% of the course grade. The difficulty of quiz problems is intended to be equivalent to those on the Final Examination. You must show your work on Quizzes and Exams to receive partial and/or full credit. Quizzes will be open book with one note sheet allowed. Each quiz will focus on assessing your learning of a subset of the course objectives. Quiz 1 will focus on objectives 2-4, quiz 2 will focus on objectives 4-5, and quiz 3 will focus on objectives 4-6.

Final Examination (30%)
There will be a cumulative final examination for this course that will assess the extent of your learning of course objectives 2-6. It will also be open book with three note sheets allowed.

Process Flow Sheet Project (15%)
You will complete a major process design project with an assigned team. You must collaborate with your teammates to integrate all of the course concepts to determine the detailed process flow sheet for a complex chemical process. More details on this project and your team assignments will follow later in the course.

Homework (10%)
Homework is assigned almost every week during the semester for students to practice problems and concepts introduced in the course. Homework is an important part of this course as it provides an opportunity to practice and repeat engineering problems to improve learning retention. Homework is unpledged and collaboration on assignments is encouraged. Your solution, however, must be your own.

Course Materials:

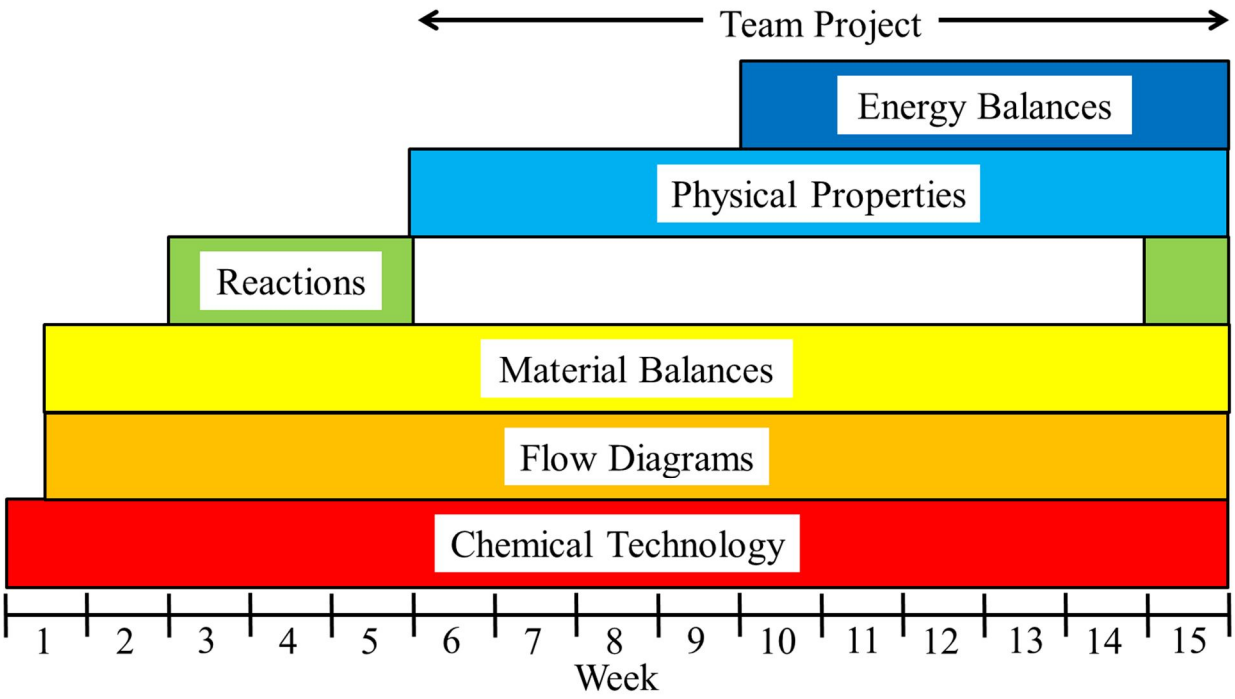
Text: Felder, Richard M. and Rousseau, Ronald W.; "Elementary Principles of Chemical Processes", Third Edition; John Wiley & Sons, Inc.; 2005

References: Perry and Green; "Perry's Chemical Engineers' Handbook", 8th Edition; McGraw-Hill; 2008; available in reference section of Brown Science and Engineering Library (there are some online sources for Perry's including in the past via knovel.com, but the availability is not always reliable); a CD of the 7th edition is also available in the ChE Study Room in Wilsdorf Hall

Yaws, Carl L.; "Yaws' Handbook of Thermodynamic and Physical Properties of Chemical Compounds"; Knovel; 2003; available online at www.knovel.com (search "Yaws' Handbook" for relevant resources)

The CD that comes with Felder and Rousseau, as well as the reference tables in the text and the appendix, will also be used for physical property data. Note that the UVa library maintains a Library Guide for Chemical Engineering at: http://guides.lib.virginia.edu/content.php?pid=16844

Objectives Timeline:



Detailed List of Topics:

1. Introduction to Chemical Engineering (Ch. 1) – 2 Classes
(Ch. 2 and Ch. 3 are review material that are studied outside of class)

2. Material Balances (Ch. 4) – 14 Classes

    A. General balance equations, flow charts, degree of freedom analysis, solution strategies, systems involving multiple units, recycle and bypass

    B. Balances for reactive systems with single reaction, species and element balances

    C. Balances for reactive systems with multiple reactions

3. Properties of Single and Multiphase Systems (Ch. 5 and Ch. 6) – 10 Classes

    A. Equations of state for ideal and real gases

    B. Phase equilibrium, VLE, phase diagrams

4. Energy Balances (Ch. 7, Ch. 8, and Ch. 9) – 15 Classes

    A. First law of thermodynamics

    B. Calculations of properties of state

    C. Energy balances for non-reactive systems

    D. Energy balances for reactive systems

Tentative Schedule:

Date(s)	Topic
8/27-8/29	1
9/1-9/19	2 A,B
9/24	Review
9/26	Quiz 1
9/29-10/3	2 C
10/6-10/22	3 A,B (Project Assigned)
10/24-10/27	4A
10/29	Review
10/31	Quiz 2
11/3-11/19	4 A,B,C,D
11/21	Review
11/24	Quiz 3
12/1-12/3	4D
12/5	Review (Project Due)
12/13	Final Exam

Course Policies:

Honor System

The following is a statement previously given by the SEAS Honor Committee Representatives:

The School of Engineering and Applied Sciences relies upon and cherishes its community of trust. We firmly endorse, uphold, and embrace the University's Honor principle that students will not lie, cheat, or steal, nor shall they tolerate those who do. We recognize that even one honor infraction can destroy an exemplary reputation that has taken years to build. Acting in a manner consistent with the principles of honor will benefit every member of the community both while enrolled in the Engineering School and in the future.

Information about the Honor System can be found by accessing www.virginia.edu/honor. Contact information for the current SEAS Honor Committee representatives can also be found at the website, and representatives should be contacted regarding Honor System questions or reports of suspicions of an Honor Offense.

Absences and Missed Assignments Policy

Lectures, homework, project assignments, quizzes, and tests are expected to be attended/submitted at the scheduled date and on time. Any arrangements with regards to special emergency situations or authorized university activities must be made in advance with the instructor.

Learning Accomodations

All students with special needs requiring accommodations should present the appropriate paperwork from the Student Disability Access Center (SDAC). It is the student's responsibility to present this paperwork in a timely fashion and follow up with the instructor about the accommodations being offered. Accommodations for test-taking (e.g., extended time) should be arranged at least 7 days before an exam.

The SDAC is located in the Department of Student Health and can be contacted at 243-5180/5181.