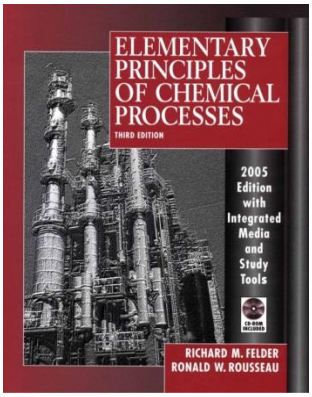
Spring Syllabus 2014

CHE 317 • Intro to Chemical Engineering Analysis • by Dr. Marsha J Lewis



FACTORS FOR UNIT CONVERSIONS

Quantity	Equivalent Values
Mass	1 kg = 1000 g = 0.001 metric ton = 2.20462 lb_m = 35.27392 oz 1 lb_m = 16 oz = 5×10^{-4} ton = 453.593 g = 0.453593 kg
Length	1 m = 100 cm = 1000 mm = 10^6 microns (μm) = 10^{10} angstroms (Å) = 39.37 in. = 3.2808 ft = 1.0936 yd = 0.0006214 mile 1 ft = 12 in. = 1/3 yd = 0.3048 m = 30.48 cm
Volume	1 m^3 = 1000 L = 10^6 cm^3 = 10^6 mL = 35.3145 ft^3 = 220.83 imperial gallons = 264.17 gal = 1056.68 qt 1 ft^3 = 1728 $in.^3$ = 7.4805 gal = 0.028317 m^3 = 28.317 L = 28.317 cm^3
Force	1 N = 1 kg·m/s^2 = 10^5 dynes = 10^5 g·cm/s^2 = 0.22481 lb_f 1 lb_f = 32.174 lb_m·ft/s^2 = 4.4482 N = 4.4482×10^5 dynes
Pressure	1 atm = 1.01325×10^5 N/m^2 (Pa) = 101.325 kPa = 1.01325 bar = 1.01325×10^6 dynes/cm^2 = 760 mm Hg at 0°C (torr) = 10.333 m H_2O at 4°C = 14.696 $lb_f/in.^2$ (psi) = 33.9 ft H_2O at 4°C = 29.921 in. Hg at 0°C
Energy	1 J = 1 N·m = 10^7 ergs = 10^7 dyne·cm = 2.778×10^{-7} kW·h = 0.23901 cal = 0.7376 ft·lb_f = 9.486×10^{-4} Btu
Power	1 W = 1 J/s = 0.23901 cal/s = 0.7376 ft·lb_f/s = 9.486×10^{-4} Btu/s = 1.341×10^{-3} hp

Example: The factor to convert grams to lb_m is $\left(\frac{2.20462\ lb_m}{1000\ g}\right)$.

Course & Section(s):	CHE 317 (Unique #: 14995, 15000)
Instructor/PI:	Dr. Marsha J. Lewis
Email	marsha.lewis@utexas.edu
Office hours	
Responsibilities:	conduct lectures, hold office hours, exam re-grades
Teaching Assistant:	Shira Cramer
Email	shira.cramer@gmail.com
Office hours	Monday 1:30 to 3:30pm CPE 4.446
Responsibilities:	conduct recitations and substitute lectures, office hours, gradebook
Tutor:	TBA
Email	
Office hours	
Responsibilities:	hold office hours
Internet Resource:	CANVAS
Meeting times:	Tuesday and Thursday: 9:30 to 11:00 in SZB 370 Friday: 1 to 3pm in CPE 2.216 **(Note: Both sections meet together!)**
Required Textbook:	R.M Felder, R.W. Rousseau, *Elementary Principles of Chemical Processes*, 3rd Edition. Wiley, 2005.

Introduction

Welcome to Introduction to Chemical Engineering Analysis (CHE317)!

This course will be an exciting next step in your journey of professional development. *Notice*: I did not say in your journey to become a chemical engineer! You may be feeling nervous, confident, or a bit of both right now. Over the course of the semester, you may feel a little bit of all of the above at different times. I hope my life experiences in the fields of chemical engineering, biology, chemistry, management, manufacturing, teaching, and research will put me in a position to positively instruct and mentor you through this semester. You are all here because you were extremely successful at your high school or your community college and in college placement exams. You are all well qualified to begin this course and for the field of chemical engineering. However, some of you may find that you don't have the desire to complete this course or you may complete this course and change your path afterwards because chemical engineering is not what you had thought. Most of you, will stick with the chemical engineering path. I am here as an experienced voice and sounding board as you contemplate and make these decisions this semester.

Course Goals and Overview:

Material and Energy Balances form the foundation for nearly all future chemical engineering courses and analysis. The process of account for mass and energy is akin to "chemical accounting" and in this course we will learn how to formulate the balances that govern systems in which mass and energy are exchanged. Included in this analysis are both reactive and non-reactive systems. An overview of physical behavior will be included to provide an introduction to energy balances. Overall, this course will provide an introduction to the principles and calculation techniques used in the field of Chemical Engineering as well as provide an exposure of the various areas and facets of current Chemical Engineering research. This course is designed to:

- Provide you with the fundamentals of material and energy balances as applied to chemical engineering to enable the analysis of a chemical process
- Develop efficient methods of and life-long skills for problem solving through exercise problems and thought experiments
- Offer practice in defining problems, collecting data, analyzing data

Course Objectives

To introduce students to the principles and calculation techniques used in the field of chemical engineering.

- To apply concepts learned in previous courses: Chemistry, Physics, Math
- To acquaint students with the fundamentals of material and energy balances as applied to chemical engineering.
- To acquaint students with efficient methods of problem solving so that they can effectively solve problems they will encounter after leaving UT.
- To offer practice in defining problems, collecting data, analyzing the data and breaking it down into basic patterns and selection of pertinent information for application.
- To help a student device whether he or she has chosen the right field of study.

Knowledge, abilities and skills students should have BEFORE entering this course:

- One year of freshman mathematics (algebra, solution of simultaneous equations, quadratic equations, basic differentiation and integration, trigonometry and basic geometry – calculate area and volume of simple shapes). *M408C, M408D.*
- Chemistry (stoichiometry, concept of a mole, molecular weight, concentration, molarity, molality, etc; enthalpy of reaction, ideal gas law, pressure, absolute temperature). *Chem302, Chem 204.*
- Basic knowledge of statics and dynamics in physics (concepts of force, work, pressure, kinetic energy, potential energy). *Phys 303 or high school physics.*
- Spreadsheet calculations for solving systems of linear equations, function minimization and plotting. *Che 210.*
- Time management skills to balance courses, assignments, exam preparation, and extra-curricular activities.

Knowledge, abilities and skills students should GAIN from this course:

- Exposure to systems analysis and the concept of unit operations.
- Exposure to library and reference data sources and the need to use them as an engineer.
- Ability to make calculations using different sets of units, including the appropriate use of the gravitational conversion factor and gage vs. absolute pressure.
- Ability to write and balance chemical reaction equations. Ability to identify the excess and limiting reactants and calculate the percent conversion and yield of a reaction.
- Ability to define steady-state and distinguish between open and closed systems.
- Ability to solve material balances for systems with or without a chemical reaction. Ability to solve a number of interconnected units involving recycle, bypass and purge.
- Ability to apply Dalton's and Amagat's laws for ideal gas mixtures.

- Ability to define vapor pressure, saturation, equilibrium, triple point, dew point, partial saturation (humidity), etc.
- Ability to apply Raoult's and Henry's laws for multi-component systems.
- Ability to apply the phase rule.
- Ability to define heat, work, energy, enthalpy, etc.
- Ability to make estimations of heat capacity and to calculate enthalpy changes, with and without phase changes.
- Ability to use the steam tables.
- Ability to solve energy balances for closed and open systems, with and without chemical reaction.
- Ability to solve simple combined material and energy balances (with and without chemical reactions).
- Ability to distinguish and make calculations for adiabatic and non-adiabatic processes.
- Ability to apply spreadsheet calculations to mass/ energy problems.

Chemical Engineering Program Outcomes to be achieved:

- An ability to apply knowledge of mathematics, chemistry, physics and computing.
- An ability to apply and integrate the major elements of chemical engineering to solve problems of analysis.
- An ability to participate effectively in team-oriented activities.
- An ability to learn to communicate effectively in written form.

Impact on subsequent courses in the curriculum:

Virtually every subsequent ChE course requires concepts from material and energy balances. In addition, properties of materials (gas laws, vapor pressures, etc) are important in ChE 322, 354, 350, 363 and 473K.

Course Policies and Procedures

Attendance in lecture or discussions is encouraged but not required. If you do attend any class, *please arrive promptly*, attentive and ready to work.

- *Lecture* hours will be used to introduce new material, provide detailed examples, quizzes.
- *Recitation* hours will be used to conduct quizzes and exams, provide homework solutions, extra time on difficult topics. Recitation occurs every Friday afternoon per the course schedule.
- *CANVAS* will be used to post homework assignments and solutions, assignment grades and any announcements. Please check CANVAS **at least weekly**.

Grading

Overall Evaluation Standard & Grade Assignment

The relationship between what you earn during the course (percentage), the final grade I assign and the eventual credit awarded is explicitly shown in the table below (Table 1). No exceptions or adjustments will be made to final grade percentages - what you earn will determine your final grade. The distribution of points is shown in Table 2.

Table 1. The percentage of points earned and corresponding letter grade.

What You Earn	What I Assign	University Credit	What You Earn	What I Assign	University Credit
≥ 92	A	4.0	≥ 70 C-	1.67	
≥ 90	A-	3.67	≥ 67	D+	1.33
≥ 87	B+	3.33	≥ 62	D	1.0
≥ 82	B	3.0	≥ 60	D-	0.67
≥ 80	B-	2.67	< 60	F	0.0
≥ 77	C+	2.33			
≥ 72	C	2.0			

Table 2. The point distribution between assignments, exams and quizzes.

Homework	**15%**	Posted on CANVAS, due the following FRIDAY at 1 pm in class. Please follow the HW formatting guide posted on CANVAS. **No late HW accepted**. Plan ahead! Arrange to turn in homework early, if necessary.
Quizzes	**15%**	Based on homework, these will be given Friday or Thurs in class. These are designed to be a check that you are keeping up and understanding the material. No quizzes on Exam weeks. **Lowest quiz score will be dropped;** if you miss a quiz, this will be your dropped quiz.
Exams (3)	**16.7% x 3**	Exams dates and sections covered are noted in the schedule. There will be **no make-up exams.**
Final	**20%**	Time and room determined by the college. Registration for this course includes the University-scheduled final exam date; there will be **no make-up final.** **This is a cumulative exam.**

Please show the detailed steps/ logic you follow in solving a problem (i.e., a diagram of the problem, define variables, analytical approach and equations used/ derived) – grading will be

based primarily upon these steps, *not entirely* upon a correct final answer. We want to give you points, but there needs to be something on page to justify them and we don't know what you are thinking unless you tell us explicitly!

Reading assignments Each lecture period is associated with a reading assignment in the textbook. Read the section, work the example problems and use the *Key ideas, Key words, Self-assessment tests, Thought problems and discussion questions* as a guide to whether you have fully understood the material.

Homework problems are for you to *practice* using the concepts and equations and are representative of those on exams. It is in your best interest to *struggle* with the problems, to understand why a certain approach is chosen and the details of each step. Working in groups is encouraged, provided all members contribute and benefit. Your HW must be neatly presented in the standard chemical engineering format.

Quizzes will be unannounced and will consist of one to two problems. These will be based on material covered in the classroom, reading assignments and homework.

Exams will be based upon material covered in lecture and in the homework; reading assignments complement lecture and provide additional examples for practice.

- The exam will be closed notes, closed book. All required equations and other key information will be provided.
- **Exams will be conducted during the 2 hour recitation period** and will be a combination of simpler problems (i.e., knowledge-based or those similar to HW and class examples) and more challenging problems (i.e., in which you apply the concepts in a slightly different way). These are not intended to be tricky but to probe the depths of your understanding. You will be guided through these problems.

Re-grades will be accepted up to one week after the assignment's return. Exam re-grades will be performed by the instructor and will include a re-grade of the *entire* exam.

Final grades will be assigned based on the overall grade distribution using the class mean and standard deviation. In general, if you are above the mean, you are doing fine; if you are consistently more than one standard deviation below the mean, we should talk to find out what's going on and/ or adjust your study strategies. Of course, if there is no distribution because everyone is doing so well, I am happy to give all A's.

Changes in schedule

The instructor reserves the right to change the order and content of lectures as necessary. Exam dates may be changed by the instructor, but in each case, at least 5 days notice will be given.

Absences No excuses for missed homework, quizzes or exams will be accepted other than (1) certified medical excuses or (2) written letters on University letterhead for UT-related activities.

How to succeed in this class

- *Diagram the problem* - The math is not as hard as envisioning the physical situation – always draw pictures to identify the direction of mass transfer, flow, the layers of resistance, etc.
- ***Do the homework*** – preferably not just the night before it's due and try to understand the steps. Working in groups is great as long as all members understand the solutions.
- *Do more than the HW* – periodically, look over and try to understand your notes, read the text, explain things to your roommate – whatever works for you! Often it helps to *turn off all electronics* in order to focus high quality effort on the task at hand.
- *Ask questions* – help us to help you! We have time available six days a week (see below, current 1/18/10).

Reference databases

http://dippr.byu.edu/public/chemsearch.asp?login=true&userid=utaustin&userpass=library

http://lorien.ncl.ac.uk/ming/distil/distil0.htm

Unit conversions: http://www.onlineconversion.com/

Test taking tips: http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/testtaking.htm

Lecture Topics and Reading

The content has been organized into four main sections. Each section has a set of associated lecture notes and extra practice problems, available on CANVAS.

DATE	TOPIC	READING
1 INTRODUCTION TO ENGINEERING ANALYSIS		
1/14 T	Course and ChE introduction	Syllabus, Chapter 1
1/16 TH	Dimensions, units, conversions	Chapter 2
1/17 F	*Recitation 1: Dimensional ledger, Engineering design*	

1/21 T	Process variables	Chapter 3
1/23 TH	Mass and Volume	Chapter 3
1/24 F	*R2: Problem solving, degrees of freedom*	
1/28 T	Temperature & pressure	Chapters 3
1/29 W	12th class day	
	LAST DAY TO ADD OR DROP AND GET REFUND	
2 MATERIAL BALANCES		
1/30 TH	Fundamentals of Material Balances	Chapter 4
1/31 F	*R3: manometer applications*	
2/4 T	Problem solving: definition & strategies	Chapter 4
2/6 TH	Exam 1 review	
2/7 F	*R4:* ***Midterm Exam 1***	
2/11 T	Problem solving: definition & strategies	
2/13 TH*	Single, non-reactive units	Chapter 4
2/14 F	*R5: practice problems*	
2/18 T	Accounting for reactions	Chapter 4
2/20 TH	Accounting for reactions	
2/21 F	*R6: Furnace, rxn problems*	
2/25 T	Systems with reactions	Chapter 4
2/27 TH	Multi-unit processes with reaction	Chapter 4
2/28 F	*R7: multi-unit systems*	
3/4 T	Material balances with recycle, bypass & purge	Chapter 4
3 Behavior of gases, vapors, liquids and solids		
3/6 TH*	Ideal gases and mixtures	Chapter 5
3/7 F	*R8:* ***Midterm Exam 2***	
3/11 T	Spring break!	
3/13 TH	Spring break!	
3/14 W	Spring break!	
3/18 T	Multi phase systems	Chapter 6
3/20 TH	Vapor pressure: Antoine eqn, Cox chart, steam tables	Chapter 6
3/21 F	*R9: Formulas/ Laws, steam tables*	
3/25 T	Saturation, condensation, vaporization	Chapter 6
3/27 TH	Vapor-liquid equilibrium	Chapter 6
3/28 F	*R10: Humid air ex*	
3/31 M	**LAST DAY TO WITHDRAW W/O PENALTY**	
4/1 T	VLE and review	
4 ENERGY BALANCES		
4/3 TH	Energy types	Chapter 7
4/4 F	*R11:* ***Midterm Exam 3***	
4/8 T	Non-reactive energy balances	Chapter 8
4/10 TH	Enthalpy changes	Chapter 8
4/11 F	*R12: energy balance problems*	
4/15 T	Energy balances without reaction	Chapter 8
4/17 TH	Combined mass and energy balances with reaction	Chapter 9

4/18 F	*R13: energy balance problems*	
4/22 T	Combined mass and energy balances with reaction	Chapter 9
4/24 TH	Application and analysis of combined mass and energy balances	
4/25 F	*R14: practice problems*	
4/29 T	Application and analysis of combined mass and energy balances	
5/1 TH	FINAL REVIEW, COURSE EVALS **LAST CLASS DAY**	
5/2 W	*R15: Final review*	
5/12-18	**CUMULATIVE FINAL EXAM**	

**Schedule is subject to minor modifications which will be noted on CANVAS and in class.

Additional University Policies and Resources of Significant Note

Academic Integrity

Each student must be vigilant of academic integrity at all times. The University of Texas at Austin Honor Code states:

The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

Academic dishonesty will not be tolerated and will be dealt with in as severe a manner as possible. Standards for Academic Integrity at UT Austin are detailed at http://deanofstudents.utexas.edu/sjs/acint_student.php

Accommodations for Religious Holidays

By UT Austin policy, you must notify the instructor of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, you will be given an opportunity to complete the missed work within a reasonable time after the absence.

Notice for Students with Disabilities

Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities, 471-6259, http://www.utexas.edu/diversity/ddce/ssd/

Drop Policy

The State of Texas has enacted a law that limits the number of course drops for academic reasons to six (6). As stated in Senate Bill 1231:

"Beginning with the fall 2007 academic term, an institution of higher education may not permit an undergraduate student a total of more than six dropped courses, including any course a transfer student has dropped at another institution of higher education, unless the student shows good cause for dropping more than that number. "

The academic calendar for each semester is provided at http://registrar.utexas.edu/calendars. During the fourth class day, students may add or drop courses with the Registrar's online registration service, ROSE. During days 5 through 12, students may drop courses online, but must go to the department offering the course to seek permission to add a course. Every college is a little different, so please consult the respective college about adding or dropping a class after the fourth day. Approximately the 49th class day is the last day to drop a course with approval. You must get a form from the dean's office after the 12th day to drop a course up to the 49th class day. Students now have the option to drop a class or drop all of their classes in a semester right up to the last class day. See the following link for more information: http://www.utexas.edu/faculty/council/2010-2011/legislation/EPC_OTE.html

Behavior Concerns Advice Line (BCAL)

If you are worried about someone who is acting differently, you may use the Behavior Concerns Advice Line to discuss by phone your concerns about another individual's behavior. This service is provided through a partnership among the Office of the Dean of Students, the Counseling and Mental Health Center (CMHC), the Employee Assistance Program (EAP), and The University of Texas Police Department (UTPD). Call 512-232-5050 or visit http://www.utexas.edu/safety/bcal