

Quantitative Analysis (CHEMISTRY 2270-1 and 2270-2,3 Lecture/Lab Combined Course) Syllabus

Spring 2022 (March 28 to Jun 7)

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Lecture: 11:00 AM – 11:50 AM MWF. Boettcher 101.

Laboratory: Lab sessions will start in Week 1. Section 2 lab meets Mondays at 2:00 - 4:50 PM and Section 3 lab meets Tuesdays at 2:00 - 4:50 PM in Olin 225.

Office Hours: I am here to help you learn. I have an open-door policy. If I am in my office, just come on in.

Textbook:

There is no specific textbook for this course because textbooks are just reference material. Material covered in this course can be found in any quantitative analysis textbooks or reliable web sites. Here are some textbooks that are normally used by other institutions/instructors:

1. <https://open.umn.edu/opentextbooks/textbooks/486>

Textbooks in the above Open Textbook Library link are considered open because they are free to use and distribute and are licensed to be freely adapted or changed with proper attribution.

This online textbook provides a good alternative to other analytical chemistry books. It covers all the content in an undergraduate analytical chemistry course and the necessary fundamental at an appropriate level for this course.

2. Quantitative Chemical Analysis, by D.C. Harris
3. Fundamentals of Analytical Chemistry, by Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch.

Materials Provided by Instructor:

Course materials will be distributed on Canvas. Power Point Presentation of the summary of concepts covered in the lectures will be available on Canvas. The power point presentations are just prelude to the extensive and detail coverage of the topics in the lectures. Laboratory schedule and experiments for the laboratory will also be posted on Canvas.

Course Description:

This course is intended to provide you with the basic principles of quantitative chemical analysis by introducing you to the fundamental theories and methods. You will learn how to apply the concepts of chemical equilibrium covered in General Chemistry quantitatively to the field of chemical analysis, through a combination of lectures and laboratory experiments.

Number of Credit Hours: 4 Quarter hours; 3 hours lecture and 1 hour of laboratory. A single grade is given for both laboratory and lecture.

Course Prerequisites:

This course builds upon and follows General Chemistry I, General Chemistry II, and Chemistry of the Elements. CHEM 2270 assumes that you have a good conceptual understanding of material covered in all three of these courses. **It is not the grade you received; it is the knowledge at your disposal.** This course assumed that you have a solid grasp of college level math including algebra. You will need to be able to do algebraic manipulations relatively well.

Course Overview:

When you learn how to do something, you have a skill, all you can do is use it the same way over and over. But when you understand how something works, you can reason and expand upon them infinitely, you simply own it intellectually. Chemistry is an experimental science and all the theories and concepts that the students learn in the lectures originated from attempts to explain experimental observations. The reason many people find chemistry difficult is because they do not fully understand the fundamental concepts. Contrary to what you have been led to believe, chemistry is NOT learned by memorization, practice problems or homework problems. **Practice does not make perfect in chemistry.** Developing logic and reasoning skills are essential for the understanding of chemistry, which demands a higher level of thinking. The purpose of this course is to provide students with an in-depth knowledge of the principles and applications of chemistry and to cultivate deductive reasoning skills. I do not believe in any gimmicks like clickers or online homework, they simply do not enhance student understanding of chemical concepts. Chemistry is about how well you can apply concepts to solve real life problems, not how well you can do exam problems. ***If you are accustomed to plug and chug method in Chemistry and your learning is based on memorization and practice problems this course will not be a good fit.***

Course Objective:

To provide students with a more in-depth understanding of the basic concepts and theories of the topics discussed in the first year of chemistry courses and to apply the knowledge with critical thinking to solve real life chemistry problems at an advanced level. The student will develop an appreciation for chemistry as it relates to the other disciplines and will recognize how chemistry provides solutions to contemporary, historical, technological, and societal issues.

Course delivery:

This is an in-person course. My lectures combine classic “chalk- talks” and lecture supplements (PPT). I will make every effort to explain all topics in detail and keep it relevant. I prefer feedback type lectures and encourage students to ask questions during the lecture. We may need to adjust or change, either to content or course procedures, as circumstances warrant. I pledge to uphold the standard and integrity of this course despite situations we may encounter.

Course Etiquette:

Respect your fellow classmates and refrain from personal attacks or demeaning comments of any kind.

Refrain from whispering or talking to your neighbor during class. It is disruptive and annoying to those around you trying to listen to the lecture. If there is something you do not understand or have a question, please address the question to me. If you are uncomfortable asking the question in front of the class, you can talk to me after class.

All forms of electronic devices (cell phones, computers, earphones etc.) must be turned off and put away during class/lab. This means no networking during class.

Exams:

All exams are essay type and administered in class. There are a total of 3 exams.

a) There will be two one-hour exams and a final exam. **There will not be any make up exams under any circumstances** and your final grade for the course will be determined by your performance in **all the three exams and the Lab**. If your score in the final exam is higher than any of the scores in the one-hour exams, the final exam score will replace the lowest score.

b) **All exams are comprehensive, encompassing lecture and laboratory material. The exams are designed to test your ability to apply the concepts covered in the lecture.**

c) *Raw exam scores will be posted on Canvas and does not reflect your actual grade. I will do statistical analysis on the overall performance of the class in each exam and discuss the grade distribution in the lecture.*

d) **I reserve the right to adjust the posting and due dates of exams to make allowances for the progress of the class.**

e) **All exams are nonnegotiable documents. I will be the judge of the right and wrong answers.**

Lab:

Although separate, the lab is an integral part of this course. Lab is the “hands-on” experience essential to learning chemistry, gives you the experience of putting the key concepts covered in lecture into practice. Your lab grade will be based on how close your experimental value matches the true value. Your comprehension of the material covered in the laboratory will be tested via the exams given in the lecture course.

Grading:

The breakdown of the course grades is as follows:

Lab	200 points
Exam 1	200 point
Exam 2	200 points
Final Exam	<u>200 points</u>
TOTAL	800 points

Tentative Schedule of Lecture Topics

Date	Day	Topic
3/27 3/29 3/31	M	<p style="text-align: center;">Analytical Process</p> <ul style="list-style-type: none"> introduction to the analysis of real samples; sample handling and preparation, quantitative transfer, and elimination of interferences. (Will be covered in Lab) <p style="text-align: center;">Statistics</p> <p style="text-align: center;">https://sites.chem.utoronto.ca/chemistry/coursenotes/analsci/stats/LinRegrMain.html</p> <ul style="list-style-type: none"> random and systematic errors, ways to minimize them, basic statistics (population parameters and sample statistics), normal distribution, concept of hypothesis testing and significance level (type of errors, evaluation of errors, z-test, t-test, Q-test etc.). concept of gravimetric analysis including experimental aspects.
	W	
	F	
4/3 4/5 4/7 4/10 4/12 4/14	M W F M W F	<p style="text-align: center;">Chemical Equilibrium</p> <ul style="list-style-type: none"> principles of titrimetric methods of analysis, with emphasis on dilution of solutions, equivalence, titration curves for complex acid/base systems, precipitation titrations, oxidation/reduction titrations, potentiometric titrations, and complex-formation titrations.
4/17	M	Exam 1, (50 minutes)
4/19 4/21 4/24 4/26 4/28 5/1	W F M W F M	<p style="text-align: center;">Activity and the Systematic Treatment of Equilibrium</p> <ul style="list-style-type: none"> Ideal and non-ideal solutions; hydrated ions, ionic atmosphere, ionic strength, activity of ions, and application of the Debye-Huckel equation to thermodynamic equilibrium constant. concept of equilibrium as it applies to complex systems. Alpha plots.
5/3 5/5 5/8 5/10 5/12	W F M W F	<p style="text-align: center;">Electrochemistry</p> <ul style="list-style-type: none"> principles of electrochemistry; electrode potentials, ion selective electrodes, the Nernst equation, and the theory of potentiometry, electrogravimetry, coulometry, voltammetry.
5/15	M	Exam 2, (50 minutes)
5/17 5/19 5/22 5/24 5/26 5/29 6/1 6/3	W F M W F M W F	<p style="text-align: center;">Modern instrumental techniques</p> <p>An overview of spectroscopy, and chromatography.</p> <ul style="list-style-type: none"> basic principles of spectrochemical methods; ultraviolet and visible absorption spectroscopy and the application of Beer's Law. concepts of chromatography; Theoretical plates, van Deemter equation, liquid and gas chromatography, response factors.
6/7	Tue	FINAL EXAM, (2 hours) 10:00AM to 11:50AM Boettcher 101