

**Quantitative Chemical Analysis (CHEM 3000), 3 credits
Fall 2019**

Professor: Yi Rao

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Office Hours: Thursday (4:00 -5:00 pm) and Friday (4:00 - 5:00 pm)

Class meeting place & time: Engineering Room 106, MWF 12:30 - 1:20 pm

Help session (UTF): Ms. Alex Lish; email: alex.lish@aggiemail.usu.edu

Help session time & place: Basement of Widtsoe building, Thursday 3:00 - 6:00 pm

Course Description: The goal of this course emphasizes on the quantitative aspects of the basic analytical chemistry. The topics of the course include statistical treatment of data, error analysis, quality assurance, gravimetric and volumetric methods, titration analysis, chemical equilibria (solubility, acid-base, complexation, and oxidation/reduction), introductory electrochemical analysis, introductory spectroscopic analysis, and introductory chemical separations.

Course Objectives:

- To understand the goals of analytical chemistry, i.e., the questions analytical chemists seek to answer, and the steps required to perform quantitative analysis.
- To understand the importance of stoichiometry and chemical equilibrium in chemical analysis. Be able to apply these concepts to analytical problem solving.
- To understand how chemical reactions may be utilized for the quantitative measurement of one or more compounds (analytes) in a sample.
- To develop critical reasoning skills so that a student can calculate the concentration of analyte in an unknown sample, given an appropriate set of data.
- To develop a greater understanding of relevant chemical equilibria (solubility, acid-base, complexation, and oxidation/reduction), and to apply this knowledge in solving different types of equilibrium-based problems (pH, principal species, fractional composition, etc.).
- To understand how selected forms of instrumental analysis (i.e., potentiometry, spectrophotometry, and chromatography) may be utilized for quantitative measurements in each.
- To understand the difference between accuracy and precision and the figures of merit used to quantify them (relative error and relative standard deviation).
- To be able to perform basic statistical tests such as the Grubbs-test and the t-test on one or more sets of data.
- To understand the sources for error in chemical measurements and account for errors in data analysis
- To be able to evaluate and employ proper analytical standards and be able to formulate suitable standardization strategies
- To be able to apply basic spectrophotometric methods for various chemical analyses.
- To understand how chemical separations simplify otherwise very complex chemical analyses.

Required textbooks and other materials:

- Quantitative Chemical Analysis 9th Edition by Daniel C. Harris. W.H. Freeman and Company. ISBN 1-4292-1815-0.
- Scientific Calculator
- Microsoft Excel

Course Fees: No.

Preview lecture notes are usually posted in advance on the Canvas.

Lecture notes are updated after the lecture based on student feedback.

Attendance is mandatory. If you miss more than six meetings for the entire semester, your grade will drop one letter grade and you will forfeit all extra bonus points. If you miss class during an in-class activity then you will not be allowed to make up the activity – even if it is a take home assignment. If you have perfect attendance, have not recorded a tardy, and turn in your assignments (homework) on time, you will be awarded extra bonus credit at the end of the term. There is no makeup for quizzes.

Homework: Homework will be assigned. Due dates for these assignments will be made when homework is announced. Most of the problems are those found at the end of the chapter in your textbook. If you want good grades in your exams, do the homework and if you have to, do extra problems at the end of the chapter. By taking time to work on extra problems before the exam, you will be better prepared for the exam problems. Working problems in the book is an ideal way to prepare for this course.

Help Sessions: There is One Help Session every week. Alex Lish (UTF) will run the session. It is scheduled on Thursday from 3:00-6:00 pm. Please make full use of this opportunity.

In-class exercises and “take-home” problems: More often than not, there will be at least one in-class exercise for each topic. As long as you are visibly trying to work on “take-home” problems when it is assigned, you will receive full credit regardless of whether you finished it or got the correct answer. On the other hand, if you are absent from class on a day in which an in-class exercise is assigned, you will receive a score zero (0) for that exercise.

I-Clicker: i-clicker will be used in the classroom for two purposes: 1) check attendance; 2) in-class exercises.

Grading: Three in-class hour exams and one cumulative final exam will be given. See course outline below for tentative dates for each exam and the material to be covered. There will be no graded homework. Only written medical excuses or other (documented) extenuating circumstances will be accepted for missing an exam (see below). Three two-hour exams and a final exam will all contribute equally to your class grade (100 pts for each exam). The final examination will be comprehensive and will cover material from the entire semester. The final examination is currently scheduled for December 11th, Wednesday (12:30-2:20 PM) in Engineering 106.

Tentative Grading Scale

A: 100-90% B: 89-80% C: 79-70% D: 69-60% F: below 60%

Course Withdrawal: Students may withdraw from Chemistry 3000 as outlined in the on-line edition of the Utah State University General Catalog (see: <http://catalog.usu.edu/content.php?catoid=4&navoid=489> Dropping_Courses).

Additional Provisions: The administration of Chemistry 3000 will adhere strictly to the USU Academic Policies outlined in the on-line edition of the Utah State University General Catalog (see: <http://catalog.usu.edu/index.php>). The complete code of Policies and Procedures for Students can also be viewed online at: <http://catalog.usu.edu/content.php?catoid=12&navoid=3139>.

Disability Statement: In accordance with the Americans with Disabilities Act, reasonable accommodation will be provided for all persons with disabilities in order to ensure equal participation in Chemistry 3000. A student who requires an accommodation must contact the Instructor. The disability must be documented by the Disability Resource Center. In cooperation with the Disability Resource Center, reasonable accommodation will be provided for students with Disabilities. Course material may be requested in alternate formats through the Disability Resource Center.

Tentative Course Outline for CHEM 3000 (Quantitative Chemical Analysis)

Unit I Methodology for Quantitative Analysis

1. August 26th (M) Self-review assignments
2. August 28th (W) Chapters 0 & 1. Introduction to Quantitative Analysis
3. August 30th (W) Titration and Volumetric Analysis
No class. September 2nd (Labor Day)
4. September 4th (W) Titration and Gravimetric Analysis
5. September 6th (F) Chapter 3 Experimental Error
6. September 9th (M) Chapter 3 Experimental Error
7. September 11th (W) Chapter 4 Statistics
8. September 13th (F) Chapter 4 & 5 Statistics and Calibration
9. September 16th (M) Chapter 6 Chemical Equilibrium
10. September 18th (W) Chapter 6 Chemical Equilibrium
11. September 20th (F) Chapter 7 Systematic treatment of equilibrium
12. September 23th (M) Chapter 7 Systematic treatment of equilibrium
13. September 25th (W) Review:
14. September 27th (F) Review:

Unit II Chemical Methods for Analysis

1. September 30th (M) Chapter 8 Monoprotic Acid-Base Equilibrium
2. October 2nd (W) Chapter 8 Monoprotic Acid-Base Equilibrium
3. October 4th (F) Chapter 8 Monoprotic Acid-Base Equilibrium

4. October 7th (M) Chapter 8 Monoprotic Acid-Base Equilibrium
5. October 9th (W) Chapter 9 Polyprotic Acid-Base Equilibrium
6. October 11th (F) Chapter 9 Polyprotic Acid-Base Equilibrium
7. October 14th (M) Chapter 9 Polyprotic Acid-Base Equilibrium
8. October 16th (W) Chapter 10 Acid-Base Titrations
No class October 18th (Fall Break)
9. October 21th (M) Chapter 10 Acid-Base Titrations
10. October 23rd (W) Chapter 11 EDTA Titrations
11. October 25th (F) Chapter 11 EDTA Titrations
12. October 28th (M) Chapter 11 EDTA Titrations
13. October 30th (W) Review
14. November 1st (F) Second exam

Unit III Introductory Instrumental Methods for Analysis

15. November 4th (M) Chapter 13 Fundamentals of Electrochemistry
16. November 6th (W) Chapter 13 Fundamentals of Electrochemistry
17. November 8th (F) Chapter 13 and 14 Potentiometry
18. November 11th (M) Chapter 15 Redox Titrations
19. November 13th (W) Chapter 15 & 16 Redox Titrations and Electroanalytical methods
20. November 15th (F) Chapter 17 Fundamentals of Spectrometry
21. November 18th (M) Chapter 17 Fundamentals of Spectrometry
22. November 20th (W) Chapter 18 Applications of Spectrophotometry
23. November 22th (F) Review
24. November 25th (M) Third Exam
25. *No class November 27th (Thanksgiving)*
26. *No class November 29th (Thanksgiving)*
27. December 2nd (No test week, M) Chapter 22 Analytical Separations
28. December 4th (No test week, W) Chapter 23 Gas Chromatography
29. December 6th (No test week, F) Chapter 24 Liquid Chromatography

Tips on How to do well in CHEM 3000

Practice, practice, and practice!!!

1. Pre-view (i.e. read ahead) the chapter (s) before attending the class, especially for new concepts. Get familiar with your textbook! Look what is included in the appendixes.
2. To excel in Analytical Chemistry requires 1) understanding the important concepts; 2) apply them to “hand-on” problem solving exercises that often requires calculations with chemical equilibrium concepts.
3. Our lecturing time is rather limited. Both important concepts and selected examples will be covered in the class. However, do not expect all types of questions tested will be covered exactly in the class. It is simply NOT possible to cover all types of calculations and problems within the

limited class time. It is your responsibility to work on problems related to the lecture. We will be happy to provide as much help possible per requests.

4. Team study is a proven effective way to do well in this class. Make friends and work together!

5. What will be tested from textbook? Study chapter examples (covered the answer, verify your understanding of the problem, do you know how to solve the problems?), then, Do the Exercises and verify the answers at the end of the book. Work on Assigned Problems and verify with answers from solution manual. --- Mark/collect those problems you have difficulty with for the quick review/practice right before the exam.

6. Most of exam problems will be taken from the lecture and assigned problems. Exam questions may not copy exactly, but will be rather similar.

7. Practice before exam: Before the exam, make up a simulated exam (put in some of those marked problems you have difficulty earlier) and give yourself one hour and half on the simulated exam.

8. After each exam, make sure you understand the relevant subjects and can really do the old exam problems. Make good correction notes.