

Sul Ross State University
Syllabus for Chem 240 (Fall 2016)

Class: Analytical Chemistry I

Instructor: Dr. Yanfeng Yue

Room: WSB 307; Office: WSB 217

Time: TR 11:00-11:50 am

Office Hours: Monday, Wednesday, Friday 11:00-12:00 and Tuesday 2pm-4pm

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Student Learning Objectives (SLO):

A student graduating with the *chemistry major* is expected to demonstrate that (s)he is able to do the following:

1. Organic Chemistry—Students will be able to draw organic molecular structures and explain organic reactions, stereochemistry, structural analysis and reactions in biological systems.
2. Inorganic Chemistry—The student will be able to demonstrate understanding of coordination chemistry, valence theory, elementary actions and advanced molecular theory.
3. Analytical Chemistry—The student will be able to demonstrate an understanding of theory of analytical chemistry and conduct analytical analysis, including data analysis and calibration, equilibrium chemistry, gravimetric analysis, titrimetric analysis, spectroscopic analysis, and electrochemical analysis.
4. Physical Chemistry—The student will be able to demonstrate an understanding of the application and theory of physical chemistry, including topics such as atomic structure, electrochemistry, surface chemistry, solid-state chemistry, and thermodynamics.
5. Research—The student will collect and analyze published chemical literature and undertake a chemistry research project.

Course Description:

This Analytical Chemistry course is appropriate for students who are majoring in the natural sciences, science education, engineering, and pre-professional programs. This course assumes that an adequate degree of 2 collegiate level knowledge has been achieved from a two semester General Chemistry sequence since many of the concepts discussed in this class build directly upon the material learned in freshman level chemistry such as stoichiometry, equilibrium, acid-base reactions, and electrochemistry. This course will study in detail the analytical process including the techniques and methods used to isolate and quantify specific analytes in samples of materials. Major topics that will be discussed in this course include sample preparation, equilibrium, titrations, electrochemistry, spectrophotometry, and separations. This course will focus on the quantitative procedures of measurement using chemical and instrumental methods in order to compare analysis to theoretical information obtained from equilibrium and stoichiometry using statistical methods.

General Chemistry I Learning Objectives:

A student graduating with the chemistry major is expected to demonstrate that s(he) is able to:

1. Equilibrium reactions and equilibrium constant and redox expressions
2. Analytic concentration expressions - mass balances (conservation of mass)
3. Charge balance (conservation of charge).

4. Various methods for visualizing information about solutions and titrations will be presented.
5. Electrochemical systems are included in these parameterizations through introduction of the Nernst equation.
6. Various electrochemical methods, which includes potentiometry, voltammetry, and ion selective electrodes will be presented.
7. The chemical composition of any solution at equilibrium should succumb to analysis by these protocols.
8. At the end of the semester, students will be able to appreciate quantitatively the equilibrium behavior of species in the solution and with the solution.

Required Text:

Quantitative Chemical Analysis by Daniel C. Harris ISBN-13:
9781429218153

Edition Number: 9th

Publisher: Freeman, W. H. & Company

The following chapters will be covered:

Chapter 0: The Analytical Process

Chapter 1: Chemical Measurements

Chapter 2: Tools of the Trade

Chapter 3: Experimental Error

Chapter 4: Statistics

Chapter 5: Quality Assurance and Calibration Methods

Chapter 7: Chemical Equilibrium

Chapter 8: Let the Titration Begin

Chapter 9: Activity and the Systematic Treatment of Equilibrium

Chapter 10: Monoprotic Acid-Base Equilibria

Chapter 11: Polyprotic Acid-Base Equilibria

Chapter 12: Acid-Base Titration

Chapter 13: EDTA Titration

Chapter 14: Advanced Topics in Equilibrium

Core Objectives (CO):

1. **Critical Thinking Skills** – Students will gain/improve their critical thinking ability by solving real life chemistry problems through inquiry, analysis, and evaluation of available information. Students will be tested on their critical thinking ability in exams and through lab experiments.
2. **Communication Skills** – Students will have the opportunity of improving communication skills through oral discussion and writing reports (i.e. observation, explanation, and conclusion, etc.) on the experiments done in the lab sessions.
3. **Empirical and Quantitative Skills** – Students will use the mathematical skills needed to manipulate and analyze numerical data obtained through experimentation in order to form conclusions.
4. **Teamwork** – Students will use team-spirit and consider different points of view to work effectively while conducting experiments as a team working toward a shared purpose or goal.
5. **Career Goals** – Students will be trained in a broad set of skills in many disciplines that are ideal for pursuing jobs in industry or academics in graduate schools.

Lecture sessions are designed to fulfill PLO 1, CO – 1, 2, 3, 4, and 5. Lab sessions are designed to fulfill PLO 3, CO 1-5.

Homework: There will be problems assigned for each chapter. **NO LATE HOMEWORK WILL BE ACCEPTED.**

Examinations: There will be *three midterm* examinations and *a final* examination. The final is mandatory and will be comprehensive. **NO MAKE-UP EXAMS WILL BE GIVEN.**

ATTENDANCE PRERESQUITE: BEING ABSENT FROM MORE THAN 6 LECTURES WILL RESULT IN FAILING THE COURSE.

PERCENTAGE BREAKDOWN OF MARKS:

Homework: 15%

Each Midterm Exam (15%): 45%

Final Exam: 30%

Labs: 10%

Final Exam: Wednesday, December 5 (10:15 a.m. - 12:15 p.m.)

Course Calendar

Lecture 1 (August 23): Discussion on Syllabus, importance of Analytical Chemistry, Job of Analytical Chemistry

Lecture 2 (August 25): SI units; chemical concentrations. General steps of analytical chemistry

Lecture 3 (August 30): preparing solutions

Lecture 4 (August 31): Stoichiometry calculations

Lecture 5 (September 1): safe, ethical handling of chemical waste; lab notebook; glasswares

Lecture 6 (September 6): basic analytical techniques, Significant figures, types of error

Lecture 7 (September 8): Uncertainty (Random error and systematic error), Exam Revision Chapters 1, 2, and 3

Lecture 8 (September 13): Exam I, Chapters 1, 2, 3

Lecture 9 (September 15): Gaussian Distribution; standard deviation; Confidence intervals

Lecture 10 (September 20): Comparison of means with students' *t*; *t* tests with a spreadsheet; Grubbs test for an outlier

Lecture 11 (September 22): The method of least squares; Calibration curves

Lecture 12 (September 27): Basics of Quality Assurance; method validation

Lecture 13 (September 29): Standard Addition; Internal Standard, Equilibrium constant

Lecture 14 (September 25): Thermodynamics; complex formation

Lecture 15 (October 4): Protic acids and bases, pH

Lecture 16 (October 6): Strengths of Acids and Bases

Lecture 17 (October 11): Titration; Titration calculations

Lecture 18 (October 13): Titration of mixture; Titration curves

Lecture 19 (October 18): End-point Detection, ionic strength.

Lecture 20 (October 20): Activity Coefficients

Lecture 21 (October 25): pH revised; Systematic treatments of Equilibrium

Lecture 22 (October 27): Strong Acids and bases; weak acids and bases

Lecture 23 (November 1): weak acid; weak base equilibrium

Lecture 24 (November 3): buffers, Diprotic acids and bases; diprotic buffers

Lecture 25 (November 8): polyprotic acids and bases

Lecture 26 (November 10): principle species; Fractional composition equations; isoelectric and isoionic pH, Exam Revision, Chapters 4-12

Lecture 27 (November 15): Exam II (Chapter 4-7)

Lecture 28 (November 17): Titration weak base with strong acid; titrations in diprotic systems

Lecture 29 (November 22): End point; Practice notes; nitrogen analysis; Leveling effect; titration curves; Metal-chelate complex; EDTA titration

Lecture 30 (November 24): Metal ion indicators; activity coefficients; Dependence of solubility on pH

Lecture 31 (November 29): Exam III (Chapter 8-11)

Lecture 32 (December 1): Exam Revision

Final Exam (December 5): At 10:15am

Students with Special Needs: *Sul Ross State University is committed to equal access in compliance with the Americans With Disabilities Act of 1973. It is the student's responsibility to initiate a request for accessibility services. Students seeking accessibility services must contact Mary Schwartze, M. Ed., L.P.C., in Counseling and Accessibility Services, Ferguson Hall, Room 112. The mailing address is P.O. Box C-122, Sul Ross State University, Alpine, Texas 79832. Telephone: 432-837-8203. E-mail: mschwartz@sulross.edu.*

Scholastic Dishonesty: Students who violate the University rules on scholastic dishonesty are subject to penalties, including the possibility of an **F** in the course and/or dismissal from the University. All assignments (including homework) need to be individually completed and not copied from another student's work. Electronic submission of homework is accepted after hours (not recommended), but must be hand written and scanned (either with a scanner or a smart phone) and emailed to Dr. Leaver at: djl14jh@sulross.edu or david.leaver@sulross.edu. Homework electronically completed in Microsoft Word or other similar programs will NOT be accepted.