Sul Ross State University
Syllabus for CHEM 2401 (Spring 2019)

Class: Analytical Chemistry I
Instructor: Dr. Yanfeng Yue
Classroom: WSB 307
Office: WSB 217
Time: MWF 10:00-10:50 am
Office Hours: MTWRF 11:00-12:00
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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 Textbook:
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% (Two midterm tests)
Final Exam: 40%
Labs: 15%

Course Calendar
Lecture 1 (Jan 23): Discussion on Syllabus, importance of Analytical Chemistry, Job of Analytical Chemistry
Lecture 2 (Jan 25): SI units; chemical concentrations, General steps of analytical chemistry
Lecture 3 (Jan 28): preparing solutions, Stoichiometry calculations
Lecture 4 (Jan 30): safe, ethical handing of chemical waste; lab notebook; glasswares
Lecture 5 (Feb 1): basic analytical techniques, Significant figures, types of error
Lecture 6 (Feb 4): Uncertainty (Random error and systematic error), Exam Review Chapters 1, 2, and 3
Lecture 7 (Feb 6): Exam I, Chapters 1, 2, 3
Lecture 8 (Feb 8): Gaussian distribution; standard deviation; Confidence intervals
Lecture 9 (Feb 11): Comparison of means with students' *t*; *t* tests with a spreadsheet; Grubbs test for an outlier
Lecture 10 (Feb 13): The method of least squares; Calibration curves
Lecture 11 (Feb 15): Basics of Quality Assurance; method validation
Lecture 12 (Feb 18): Standard Addition
Lecture 13 (Feb 20): Internal Standard, Equilibrium constant
Lecture 14 (Feb 22): Thermodynamics
Lecture 15 (Feb 25): Complex formation
Lecture 16 (Feb 27): Protic acids and bases, pH
Lecture 17 (March 1): Strengths of Acids and Bases
Lecture 18 (March 4): Titration
Lecture 19 (March 6): Titration calculations
Lecture 20 (March 8): Titration of mixture
March 11-15: Spring break - no class
Lecture 21 (March 18): Titration curves
Lecture 22 (March 20): End-point Detection, ionic strength.
Lecture 23 (March 22): Activity Coefficients
Lecture 24 (March 25): pH revised
Lecture 25 (March 27): Systematic treatments of Equilibrium, Exam Review Chapter 4-7

Lecture 26 (March 29): Exam II (Chapter 4-7)
Lecture 27 (April 1): Strong Acids and bases, Weak acids and bases
Lecture 28 (April 3): Weak acid; weak base equilibrium
Lecture 29 (April 5): Buffers, diprotic acids and bases
Lecture 30 (April 8): Diprotic buffers
Lecture 31 (April 10): Polyprotic acids and bases
Lecture 32 (**April 12**): Principle species (**April 12: Last day to Drop**)
Lecture 33 (April 15): Fractional composition equations; isoelectric and isoionic pH Exam Review, Chapters 4-12
Lecture 34 (April 17): Titration weak base with strong acid
Lecture 35 (April 19): Ttitrations in diprotic systems.
Lecture 36 (April 22): End point; Practice notes; nitrogen analysis; Leveling effect; titration curves
Lecture 37 (**April 24**): Metal-chelate complex; EDTA titration,Metal ion indicators
Lecture 38 (April 26): Activity coefficients
Lecture 39 (April 29): Dependence of solubility on pH
Lecture 40 (May 1): Exam III Review (Chapter 8-11)
Lecture 41 (May 3): Exam III (Chapter 8-11)
Lecture 42 (May 6): Final Exam Review

Final Exam: May 14th, 10:15 a.m. - 12:15 p.m.

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: mschwartze@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. Yue at: yanfeng.yue@sulross.edu. Homework electronically completed in Microsoft Word or other similar programs will NOT be accepted.