**CHEM 2220--QUANTITATIVE ANALYSIS**

**Text**: Exploring Chemical Analysis, 3rd Edition, 2005, Daniel C. Harris.

**Prerequisites:** CHEM 1120-1121

**Course Description:** The course describes the general concepts and fundamental principals of quantitative analysis. In this course we discuss the chemical measurements, math toolkit, statistics, quality assurance, acid-base titrations, buffers, gravimetric and combustion analysis, electrochemistry and the laws that govern them.

1. Introduction

2. Statistics

a) Significant figures

b) Accuracy and precision

c) Determinate and indeterminate errors

d) Propagation of errors

e) Calculation of mean, standard deviation, relative standard deviation

f) Gaussian or Normal Distribution

g) Comparison of two means

h) Rejection of discordant data

i) Method of Least Squares

3. Titrimetric Methods

a) Requirements of reactions for titrimetry

b) Reactions: acid-base, oxidation-reduction, precipitation, complexation

c) Molecular and formula weights

d) Concentration units, molarity, analytical concentration, weight %, ppm, ppb

e) Standardization

f) Calculations of concentration, % purity, % content

4. Gravimetric Methods

a) Requirements

b) Stoichiometry and calculation

c) Formation and properties of precipitates

d) Precipitation process

e) Purity of precipitates and contamination minimization

f) Homogeneous precipitation

g) Ignition

h) Organic precipitants

i) Applications

5. Chemical Equilibria

a) The equilibrium constant

b) Aqueous solution

1. Strong and weak electrolytes

2. Activity, activity coefficients, and ionic strength

3. Lowry-Bronsted treatment of acids and bases

c) Applications: ionic equilibria and calculation.

1. Acid-base: strong and weak acids and bases, buffers

2. Solubility: solubility constants, common ion effect

3. Complexation: stepwise and overall formation constants

4. Oxidation-reduction

6. Acid-Base Equilibria

a) Strong acid-strong base titrations

b) Weak acid-strong base titration

c) Weak base-strong acid titration

d) Other titrations

e) Indicators

f) Buffer systems

7. Complex acid-base equilibria

a) Polyprotic acids/bases

b) Amphiprotic substances

c) Titration of polyprotic acids/bases

d) Distribution of species as a function of pH

8. Complex formation titrations

a) EDTA equilibria

b) Effective formation constants

c) Indicators

d) Applications and uses

9. Solubility Equilibria

a) Precipitation titrations

b) Indicators

c) Separation by precipitation

d) Diverse ion effect, effect of pH, hydrolysis, complexation

10. Oxidation-Reduction Equilibria

a) Galvanic cells

b) Electrode potentials

c) Liquid junction potentials

d) Conventions

e) Standard hydrogen electrode

f) The Nernst equation

g) Types of electrodes: reference and inert

h) Equilibrium constant

i) Formal potentials

j) Titration curves

k) Applications

11. Potentiometric Methods

a) Indicator Electrodes: metallic, membrane, glass,solid state

b) Direct potentiometry

c) Potentiometric titration

12. Spectrophotometry

a) Interaction of radiant energy with molecules, UV-visible, IR

b) Quantitative aspects

1. Beer's Laws

2. Nomenclature

3. Instrumentation

c) Applications and calculations based on Beer’s Law

13. Gas-Liquid Chromatography

a) Definition, terms, and important equations

b) Theoretical plate concept

c) Band broadening and van Deemter equation

d) Instrumentation

14. Liquid Chromatography

a) Adsorption chromatography

b) Ion-exchange chromatography

c) Liquid-liquid partition chromatography

d) Size exclusion chromatography

e) Planar: Paper and thin layer chromatography

f) Modern liquid chromatography

1. Normal and reversed phase chromatography

2. Instrumentation

**Grading:** Homework will be assigned but not graded.

There are four examinations given during the semester (19% each).

The final examination will be comprehensive and worth 24%.

Make-up exams will only be given to students for extenuating circumstances.