Overview: Study of the fundamental principles of quantitative analytical chemistry and their applications

The content of the course includes:

I. Nature and Tools of Analytical Chemistry
   A) Analytical process
   B) Laboratory tools and techniques

II. Analytical Measurements
   A) SI units
   B) Solution concentrations
   C) Reacting unit

III. Data Handling
   A) Accuracy and precision
   B) Significant figure
      a) Error propagation
   C) Type of errors
   D) Runs test
   E) Outlier test
      a) Q test
      b) R test
      c) Tn test
   F) Data distribution
      a) Measures of central tendency
      b) Measures of variability
      c) Gaussian distribution
      d) Confidence interval
      e) Confidence level
   f) Quality Control
   g) Quality Assurance

G.) Comparing data sets
   a) Hypothesis test
   b) t test
   c) Detection limit
   d) Limit of quantitation
   e) F test

H) Correlating data sets
   a) ANOVA
   b) Least squares method
   c) Calibration
d) Correlation coefficient
e) Coefficient of Determination
I) Statistics of sampling
   a) Reliability of Analysis
   b) Type of constituents
   c) Sampling
IV. Stoichiometric Calculation and Chemical equilibrium
   A) Chemical reactions and equilibria
   B) Fraction of dissociation
   C) Calculation of pH
   D) Buffer solution
   E) Electrolyte effect
   F) Chemical activity
      a) Activity coefficient
      b) Debye-Hückel equation
   G) Simultaneous equilibria
      a) Common ion effect
      b) Systematic equilibrium calculations
      c) Acidity effect
      d) Cation separation
      e) Complexation effect
      f) Undissociated solute effect
V. Neutralization Titration
   A) Conditions for effective titration
   B) Indicators
   C) Concentration effect
   D) Determination of pK for amino acid
   E) Titration of mixtures
   F) Titration of Polyprotic Acids
      a) Polyprotic acids and their salts
      b) Titration of amphiprotic anions
      c) pH dependence
      d) Isoelectric point
VI. Gravimetric Analysis
   A) Precipitation titrations
      a) Ksp effect
      b) Type
         i) Mohr method
ii) Volhard method
iii) Fajans method

VII. Complexometric Analysis
A) Chelates
B) EDTA titration
   a) pH dependence
   b) Conditional formation constant
   c) Feasibility
   d) Auxiliary complexing agents
   e) Indicators
   f) Types
   i) Direct titration
   ii) Back-titration
   iii) Displacement titration

VIII. Introduction to Electrochemistry
A) Electrodes and reference electrodes
B) Electrode potential
C) Nernst equation
D) Formal potential
E) Electrochemical cells
F) Cell potential
G) Gibbs Free Energy vs. Keq

IX. Oxidation/Reduction Titrations
A) Equivalence-point potentials
B) Redox indicators
C) Feasibility
D) Auxiliary reagents
   a) Reducing agents
   b) Oxidizing agents
E) Common titrants
   a) KMnO4
   b) K2Cr2O7
   c) Iodine solution

X. Potentiometry
A) Potentiometric analysis cell
B) Reference electrode
   a) Saturated calomel electrode
   b) Ag/AgCl electrode
C) Liquid junction potential
   a) Liquid junction
   b) Potential development
D) Indicator electrode
   a) Glass pH electrode
      i) Boundary potential
      ii) Asymmetry potential
      iii) Measurement Errors
      iv) Selectivity coefficient
   b) Ion-selective electrode (ISE)
      i) Single-crystal ISE
      ii) Solid-State ISE
      iii) Liquid-based ISE
      iv) Compound ISE
   c) Ion-selective field effect transistor

XI. Electrolysis
A) Electrogravimetry
   a) Analysis concept
   b) Electrodes
   c) Potential of separation
   d) Types
   e) Current effect
      i) Ohmic potential
      ii) Polarization effect
   f) Non-potentiostatic method
      i) Current & potential changes
      ii) Underpotential Deposition
      iii) I-V behavior during electrolysis
   g) Potentiostatic method
      i) Three-electrode system
      ii) Cell potential and current changes
B) Coulometry
   a) Analysis concept
   b) Types
      i) Controlled-potential coulometry
      ii) Controlled-current coulometry