CH-102: Inorganic & Analytical Chemistry

Credit Hours: 3-1

Pre-requisites: None

Course Objectives

- To apply knowledge of inorganic and analytical chemistry for understanding unit processes in chemical engineering.
- Physical transformation of pure substances and compounds
- Application of chemical kinetics in materials extraction and Processing

Course Contents

a. Inorganic section

i. Overview of periodic table
ii. Atomic structure and electronic configuration (Molecular orbital theory)
iii. Dalton law, Hess law, Raoults law, Antoine equation
iv. Relative volatility, Enthalpy, Gibbs free energy, Helmholtz free energy reaction kinetics and Chemical equilibrium, Entropy
v. Transition metals, Industrial Catalyst
vi. Coordination chemistry (Theory and nomenclature, structural isomerism, stereo isomerism, coordination number and structure), colloidal chemistry
vii. Chemistry of solutions (acid base theories, pH, buffer solutions)
viii. Industrial inorganic chemistry
ix. Electrochemistry (Oxidation reduction reactions, Introduction and theory, application, fuel cells)

b. Analytical section

i. Introduction to analytical chemistry and instrumental techniques / qualitative and quantitative analysis
ii. Separation methods
iii. Chromatography-Introduction and theory
iv. Plane chromatography, Liquid-solid chromatography
v. Paper chromatography

vi. Thin-layer and column chromatography
vii. Potentiometer, pH meter
viii. High performance liquid chromatography (Introduction, components, detectors, methodology and applications)
ix. Gas chromatography (Introduction, components, detectors, methodology and applications)
x. Ion-exchange chromatography
xi. Electromagnetic radiations, Instruments for optical spectroscopy
xii. IR spectroscopy (Introduction, theory Instrumentation and application)
xiii. Mass Spectrometry (Introduction, theory Instrumentation and application)
xiv. NMR spectroscopy (Introduction, theory Instrumentation and application)
xv. UV and visible spectroscopy (Introduction, theory and application)

Course Outcomes

After completing this course, student will be able to:

- Demonstrate chemistry proficiency in analytical and inorganic chemistry
- Have firm foundations in the fundamentals and application of current chemical and scientific theories
- Are able to design, carry out, record and analyze the results of chemical experiments
- Are able to use modern instrumentation and classical techniques, to design experiments, and to properly record the results of their experiment
- Are skilled in problem solving, critical thinking and analytical reasoning. Are able to identify and solve chemical problems and explore new areas of research
- Knows the proper procedures and regulations for safe handling and use of chemicals and can follow the proper procedures and regulations for safe handling when using chemicals

List of Practicals

i. Estimation of the molarity and strength of a given sample of base by titrating it against a standard solution of acid. (Acid-Base titration)
ii. Estimation of chloride ions in given sample of water by titrating it with $AgNO_3$ standard solution. Compare the results with the permissible limit of chloride ions in water (Argentometric titration)

iii. Estimation and analysis of water hardness due to Ca^{+2} by titrating the complexed calcium ions with solution of EDTA (Complexometric Titration).

iv. Calculation of number of molecules of water of crystallization in given sample of ferrous sulphate ($FeSO_4$) sample by permanganate titration (Redox Titration).

v. Use stalagmometer to find the surface tension of given liquid sample at room temperature. Compare the experimental results with literature.

vi. Determine the melting point of the solid sample using Melting point apparatus. Compare the experimental value of melting point with literature.

vii. Estimation of metal ion concentration using Flame photometer. Identify the different colors of flame for samples.

viii. UV-Visible Spectrophotometry of given liquid sample. Observe the readings of sample for various compositions.

ix. Find the refractive index of a given sugar sample using Abbe's Refractometer apparatus. Compare the findings with the literature

x. FTIR-Spectroscopy of solid/liquid sample. Analyze the obtained results by comparing them with the literature.

xi. Find the total dissolved salt (TDS) in tap water. Compare the values obtained with the permissible level of TDS in drinking water.

xii. Determine the conductivity of electrolytic solutions of known concentration using the conductivity meter. Identify good conductors among the electrolytes.

xiii. Demonstration and analysis of the given sample by High-performance liquid chromatography (HPLC) technique.

Recommended Books:

- Brown, T. E. (2019). Chemistry: The Central Science (13th ed.). Pearson.
- Chenier, P. J. (2012). Introduction to Industrial Chemistry (5th ed.). Wiley-VCH.
- Skoog, D. A., West, D. M., & Holler, F. J. (2013). Analytical Chemistry: An Introduction (9th ed.). Cengage Learning.
- Atkins, P. W., & de Paula, J. (2018). Physical Chemistry (5th ed.). Oxford University Press.