

PHYSICAL AND ANALYTICAL CHEMISTRY

I Year B. Tech. I Semester (CHEMICAL)

Course Code:

L	T	P	C
3	0	2	4

Course Outcomes: At the end of the course the student shall be able to

CO1: Apply the principles of distribution law for solvent extraction

CO2: Apply the principles of chemical and ionic equilibrium in chemical systems

CO3: Apply Beer–Lambert law and explain the instrumentation of UV–Visible spectrophotometry.

CO4: Explain the instrumentation of infrared spectroscopy for the identification of functional groups.

CO5: Apply atomic spectroscopic techniques for the determination of metal ions.

UNIT-I:

(9 hours)

DISTRIBUTION LAW

Statement-Nernst Distribution law, Explanation and limitations of law, Modified Distribution law for association or dissociation of the solute; Applications of Distribution law- Determination of equilibrium constant from distribution coefficient, Solvent extraction, Desilverisation of lead, Distribution indicators, Principle of partition chromatography.

Learning outcomes:

At the end of the module the student will be able to

1. explain the principles of distribution law. (L2)
2. apply the principle of solvent extraction to extract solutes. (L3)
3. apply the principle of partition chromatography for separation of solutes. (L3)

UNIT-II:

(9 hours)

CHEMICAL & IONIC EQUILIBRIUM

Dynamic nature of chemical equilibrium; law of mass action; Factors affecting equilibrium – Le Chatelier's principle; effect of concentration, pressure and temperature; Applications of chemical equilibrium in industrial processes – Haber process, Contact process; Strengths of acids and bases; dissociation of polyprotic acids; titration curve of a weak polyprotic acid (H_3PO_4); common ion effect; pH of a solution; hydrolysis of salts; degree of hydrolysis; buffer solutions.

Learning outcomes:

At the end of the module the student will be able to

1. explain the principles of chemical and ionic equilibrium and the law of mass action. (L2)
2. apply Le Chatelier's principle to predict the effect of concentration, pressure and temperature on equilibrium. (L3)
3. calculate pH, degree of hydrolysis and equilibrium constants for chemical and ionic equilibria. (L3)

UNIT-III:

(9 hours)

UV-VISIBLE SPECTROPHOTOMETRY

Electromagnetic spectrum; Interaction of electromagnetic radiation with matter; Absorption, emission and scattering of radiation.

Electronic transitions; Beer-Lambert law; Instrumentation of UV-Visible spectrophotometer—Single-beam and double-beam instruments; Applications of UV-Visible spectroscopy.

Learning outcomes:

At the end of the module the student will be able to

1. explain the basic principles of spectroscopy and electromagnetic radiation. (L2)
2. apply Beer-Lambert law and in UV-Visible spectroscopy. (L3)
3. explain the instrumentation and applications of UV-Visible spectrophotometry. (L2)

UNIT-IV:

(9 hours)

INFRARED SPECTROPHOTOMETRY

Infrared spectroscopy: Principle, molecular vibrations, functional group and fingerprint regions; Instrumentation of IR spectrometer, sample handling.

Learning outcomes:

At the end of the module the student will be able to

1. explain the principles of infrared spectroscopy and molecular vibrations. (L2)
2. identify functional groups using characteristic IR absorption frequencies and fingerprint regions. (L3)
3. describe the instrumentation and sample handling techniques used in IR spectrometry. (L2)

UNIT-V

(9 Hours)

FLAME EMISSION AND ATOMIC ABSORPTION SPECTROMETRY

Atomic spectroscopy: Principles of atomic absorption and atomic emission Spectroscopy.

Flame Photometry: Instrumentation - nebulizer, burner, optical system, detector.

Atomic Absorption Spectroscopy (AAS): Instrumentation - hollow cathode lamp, atomizer, monochromator, detector.

Applications of FES, AAS for metal ion determination.

Learning outcomes:

At the end of the module the student will be able to

1. explain the principles of atomic absorption and atomic emission spectroscopy. (L2)
2. describe the instrumentation of flame photometry and AAS. (L2)
3. apply flame photometry and AAS for the determination of metal ions. (L3)

Text Books

1. Arun Bahl, B.S. Bahl and G.D.Tuli, Essentials of Physical Chemistry, 28th Edition, S. Chand Publications, 2021.
2. B. K. Sharma, *Instrumental Methods of Chemical Analysis*, Krishna Prakashan Media.

Reference Books:

1. Skoog, D. A., West, D. M., Holler, F. J., and Crouch, S. R., *Fundamentals of Analytical Chemistry*, 9th Edition, Cengage Learning, 2014.
2. Glasston & Lewis, *Physical Chemistry*, 2nd Edition, MacMillan Publishers, 1973.
3. Atkins, *Physical Chemistry*, 9th Edition, W.H. Freeman Publishers, 2010.

LIST OF EXPERIMENTS

Course Outcomes: At the end of the course the student shall be able to

- CO1: Prepare and standardize chemical solutions.
- CO2: Perform quantitative analysis of metals and acids.
- CO3: Apply distribution law and equilibrium concepts.
- CO4: Determine pH, solubility and acid dissociation constant.
- CO5: Determine viscosity and surface tension of liquids.

List of Experiments

1. Preparation and standardization of solutions
2. Determination of Sulphuric acid by NaOH
3. Determination of ferrous iron in iron ore
4. Determination of Copper ion by EDTA
5. Determination of Calcium in milk by Gravimetry
6. Distribution of iodine between Chloroform and Water
7. Distribution of benzoic acid between benzene and water
8. Determination of an equilibrium constant using distribution law.
9. Preparation and determination of pH of solutions of sodium chloride, ferric chloride and sodium carbonate
10. pH metric titration of H_3PO_4 by NaOH.
11. Determination of solubility of sparingly soluble salt (AgCl).
12. Determination of acid dissociation constant (K_a) of a weak acid.
13. Determination of Viscosity of a liquid by Ostwald's viscometer.
14. Determination of surface tension of a liquid by Stalagmometer.

Reference Books:

1. N.K Bhasin and Sudha Rani, Laboratory Manual on Engineering Chemistry, 3rd edition, Dhanpat Rai & Sons, New Delhi, 2007.
2. A.I.Vogel, A Textbook of quantitative chemical analysis, 6th edition, Pearson Education Pvt. Ltd, 2002.