JYOTI NIVAS COLLEGE AUTONOMOUS
SYLLABUS FOR 2021 BATCH AND THEREAFTER

Programme: B.Sc.
CHEMISTRY-II

Semester: II **Course Code: 21IICH2**
No. of Hours: 60

Course Objectives (COs):

At the end of the course the student should be able to:

1. Perform titrimetric and gravimetric analysis and explain the underlying principles
2. Explain electrophilic and nucleophilic substitution reactions
3. Apply Maxwell Boltzmann distribution of molecular velocities to solve numericals relating to the different types of velocities.
4. Differentiate between real and ideal gases and identify the factors responsible for the same leading to the van der Waals equation.
5. Determine density, viscosity, surface tension and refractive index of liquids and explain the factors affecting the values.
6. Explain the determination of molar mass based on colligative properties.
7. Explain the Nernst distribution law and factors affecting the distribution coefficient and its application in solvent extraction.
8. Apply the principles of X-ray diffraction in the structural determination of NaCl.

Learning Outcomes (LOs):

At the end of the course the student will be able to:

1. Perform volumetric and gravimetric analysis and explain the underlying principles
2. Explain both electrophilic and nucleophilic substitutions.
3. Explain Maxwell Boltzmann distribution of molecular velocities and solve problems relating to the different types of velocities.
4. Summarise the factors responsible for deviation of real gases from ideal behaviour leading to the van der Waals equation.
5. Enumerate the factors affecting density, viscosity, surface tension and refractive index of liquids and carry out the experimental determination in the laboratory.
6. Explain the determination of molar mass based on the colligative properties of elevation of boiling point, depression of freezing point and osmotic pressure.
7. Explain the Nernst distribution law and factors affecting the distribution coefficient and its application in solvent extraction.
8. Illustrate the structural determination of NaCl by single crystal X-ray diffraction.

UNIT-I **15 HOURS**

Titrimetric analysis: Basic principle of titrimetric analysis. Classification, Preparation and dilution of reagents/solutions. Equivalent masses of compounds. Normality, Molarity and Mole fraction. Use of $N_1V_1 = N_2V_2$ formula, Preparation of ppm level solutions from source

materials (salts), conversion factors. Numerical problems. **2hrs**

Acid-base titrimetry: Titration curves for strong acid vs strong base, weak acid vs strong base and weak base vs strong acid titrations. Titration curves, Quantitative applications – selecting and standardizing a titrant, inorganic analysis - alkalinity, acidity. **2hrs**

Complexometric titrimetry: Indicators for EDTA titrations - theory of metal ion indicators, titration methods employing EDTA - direct, back, displacement and indirect determinations, Application-determination of hardness of water. **3hrs**

Precipitation titrimetry: Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate- Volhard's and Mohr's methods and their differences. **2hrs**

Gravimetric Analysis: Requisites of precipitation, mechanism of precipitation, Factors influencing precipitation, Co-precipitation, post-precipitation. Advantages of organic reagents over inorganic reagents, reagents used in gravimetry (8-hydroxy quinoline (oxine) and dimethyl glyoxime (DMG) Numerical problems. **6hrs**

UNIT- II **15 HOURS**

Nucleophilic substitution at saturated carbon. Mechanism of S_N1 and S_N2 reactions with suitable examples. Energy profile diagrams, Stereochemistry and factors affecting S_N1 and S_N2 reactions, substrate, leaving group, effect of solvent, nature and strength of the nucleophile, Nucleophilicity versus basicity. **5hrs**

Aromatic Electrophilic substitution reactions. Mechanisms, σ and π complexes, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence (Cl, NO_2, CH_3, NH_2, OH) **6hrs**

Aromatic nucleophilic substitution reaction: S_NAr mechanism. Generation of Benzyne with mechanism. I*pso* substitution. Example-Conversion of 2,4 dinitrochlorobenzene to 2,4 dinitrophenyl hydrazine. **4hrs**

UNIT-III **15 HOURS**

Gaseous State

Elementary aspects of kinetic theory of gases, Ideal and real gases. Boyle temperature (derivation not required), Molecular velocity, collision frequency, collision diameter, Collision cross section, collision number and mean free path and coefficient of viscosity, calculation of σ and η, variation of viscosity with temperature and pressure.

Maxwell's Boltzmann distribution law of molecular velocities (Most probable, average and root mean square velocities). Relation between RMS, average and most probable velocity and average kinetic energies. (Mathematical derivation not required), law of equipartition of energy.

Behaviour of real gases: Deviation from ideal gas behaviour. Compressibility factor (Z) and its variation with pressure for different gases. Causes of deviation from ideal behaviour, van der Waals equation of state (No derivation) and application in explaining real gas behaviour. Critical phenomena - Andrews isotherms of CO_2, critical constants and their calculation from van der Waals equation, Continuity of states, Law of corresponding states. Numerical problems. **8hrs**

Liquid State

Surface Tension: Definition, determination of surface tension using stalagmometer, effect of temperature and solute on surface tension

Viscosity: Definition, Coefficient of viscosity. Determination of viscosity of a liquid using Oswald viscometer. Effect of temperature, size, weight, shape of molecules and intermolecular forces.

Refraction: Specific and molar refraction- definition and advantages. Determination of refractive index by Abbes Refractometer.

Additive and constitutive properties.

Parachor: Definition, Atomic and structure parachor, Elucidation of structure of benzene and benzoquinone. Viscosity and molecular structure. Molar refraction and chemical constitution.Numerical Problems. **7hrs**

UNIT- IV **15 HOURS**

Dilute solutions. Review of Colligative properties.

Experimental determination of molar mass of solute by 1. Berkeley-Hartley method 2. Beckmann method 3. Landsberger method. Numerical problems. **3hrs**

Distribution Law: Nernst Distribution Law - Statement. Distribution coefficient, factors affecting distribution coefficient, validity of Distribution Law, Modification of distribution law when molecules undergo a) Association b) Dissociation. Application of Distribution Law in Solvent extraction. Derivation for simple and multiple extraction. Principles of distribution law in Parkes Process of desilverisation of lead. Numerical Problems**. 5hrs**

Solids: Forms of solids. Unit cell and space lattice, anisotropy of crystals, size and shape of crystals. Point Defects.

Laws of Crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of symmetry (Symmetry elements), Crystal systems, Bravais lattice types and identification of lattice planes.

Miller indices and its calculation, X–Ray diffraction by crystals: Bragg's law and derivation of Bragg's equation, Single crystal and powder diffraction methods. Determination of structure of NaCl by single crystal method. Numerical problems. **7hrs**

References

1. Concise Inorganic Chemistry: J D Lee, 4th Edn, Wiley, (2021)
2. Fundamentals Concepts of Inorganic Chemistry, Vol 1 and 2, 2nd Edition, Asim K Das, CBS Publishers and Distributors, (2013)
3. Basic Inorganic Chemistry, F A Cotton, G Wilkinson and P. L. Gaus, 3rd Edition. Wiley. India
4. Inorganic Chemistry, 2nd Edn. Catherine E. Housecroft and A.G. Sharpe, Pearson Prentice Hall (2005)

5. Atkins Physical Chemistry.8th Edition. Peter Atkins & Julio De Paula Oxford University Press.
6. Physical Chemistry by Samuel Glasstone, ELBS (1982).
7. A Text book of Physical Chemistry, A S Negi & S C Anand, New Age International Publishers (2007).
8. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
9. A Text Book of Physical Chemistry P.L. Soni, O.P. Dharmarha and and U.N. Dash, Sultan Chand and Sons
10. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House (2018

Practical Course 2:

PART-A Inorganic Chemistry

TITRIMETRY

1. Estimation of carbonate and hydroxide present in a mixture.
2. Estimation of oxalic acid and sodium oxalate in a given mixture using standard $KMnO_4$/NaOH solution
3. Standardization of potassium permanganate solution and determination of nitrite in a water sample
4. Standardization of EDTA solution and determination of hardness of water

Gravimetry

5. Estimation of Fe^{2+} as Fe_2O_3
6. Estimation of Ni^{2+} as $Ni(DMG)_2$ complex.
7. Estimation of Ba^{2+} as $BaSO_4$
8. Estimation of Cu^{2+} as CuSCN

PART-B Physical Chemistry

1. Determination of density using specific gravity bottle and viscosity of liquids using Ostwald's viscometer (Ethyl acetate, Toluene, Chlorobenzene)
2. Study of the variation of viscosity of sucrose solution with the concentration of a solute
3. Determination of the density using specific gravity bottle and surface tension of liquids using Stalagmometer (Ethyl acetate, Toluene, Chlorobenzene)
4. Determination of molar mass of non-electrolyte by Walker-Lumsden method
5. Degree of dissociation of an electrolyte
6. Determination of partition/distribution coefficient of Acetic acid in water and cyclohexane.
7. Determination of partition/distribution coefficient of Acetic acid in water and Butanol
8. Determination of partition/distribution coefficient of Benzoic acid in water and toluene.

Open Elective II

Molecules of Life

Semester: II **No. of Hours: 42**

Course Objectives (COs):

At the end of the course the student should be able to:

1. Appreciate the important role of carbohydrates, proteins, lipids and nucleic acids as building blocks in the body
2. Discuss the importance of enzymes in biological systems and their correlation with drug action.
3. Understand the relation between metabolism and energy in biosystems

Learning Outcomes (LOs):

At the end of the course the student will be able to:

1. Classify sugars as reducing and nonreducing, mono di and poly saccharides and write their structures
2. Explain the structure of proteins
3. Illustrate the importance of enzymes and enzyme action
4. Enumerate nucleic acids and discuss the structure of DNA and RNA
5. Outline of metabolic pathways of Carbohydrate Fats and Proteins and their inter relationship.

Unit I **14hrs**

Carbohydrates

Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structures. Epimers, mutarotation and anomers.

Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Amino Acids, Peptides and Proteins

Classification of amino acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides.

Unit II **14hrs**

Enzymes and correlation with drug action

Mechanism of enzyme action, factors affecting enzyme action, Co-enzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity),

Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non competitive inhibition including allosteric inhibition).

Drug action-receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group, -NH_2 group, double bond and aromatic ring

Lipids

Introduction to lipids, classification. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Unit III **14hrs**

Nucleic Acids

Components of nucleic acids: Adenine, guanine, thymine and cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides **(nomenclature**), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (**types of RNA**), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Concept of Energy in Biosystems

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.

Reference Books

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed.,
5. W. H. Freeman. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, 2002.