JYOTI NIVAS COLLEGE AUTONOMOUS
SYLLABUS FOR 2018 BATCH AND THEREAFTER

Programme: B.Sc. **Semester: II**

CHEMISTRY PAPER II

Course Code: 18IICH2 **No. of Hours: 60**

COURSE OBJECTIVES:

This course aims to impart to the students, knowledge of:

- Fundamental concepts of Thermodynamics leading upto the Kirchoff's equation and be able to solve numericals based on equations studied.
- Properties of liquids and solutions
- Nucleophilic addition and Elimination Reactions as well as aromatic electrophilic substitutions with mechanism.
- Structures of molecules based on theories of Chemical bonding
- Water Pollution and methods of analysis of water samples
- Measurements of density, viscosity and surface tension of liquids, and water analysis (The laboratory component)

LEARNING OUTCOMES:

On completion of this course, the student should be able to:

- Understand the basic principles of energy flow in chemical reactions
- Apply the basic principles of bonding as a tool to understand chemical reactivity
- Apply the properties of liquids and solutions to better understand the choice of solvent in chemical reactions
- Design a nucleophilic substitution or elimination reactions of aliphatic organic compounds
- Theoretically plan out reactions involving aromatic compounds
- Comment on the quality of a water sample base on analysis
- Determine, density, viscosity and surface tension of a liquid and comment on the accuracy of the result.
- Be able to write a protocol and carry out an experiment to determine order of a reaction.

UNIT I

Chapter 1: CHEMICAL BONDING **17HRS**

1.1 Ionic bond – lattice energy, Born-Lande equation (derivation not required), Born-Haber cycle-calculations of lattice energies of NaCl, MgO, Problems. Properties of ionic compounds. Factors affecting formation of ionic bond. **3 HRS**

1.2 Covalent bond - Valence bond theory and its limitations, concept of Resonance, Resonance structures of NO_2, NO_3^-, hybridisation and directional characteristics – sp, sp^2, sp^3, sp^3d, sp^3d^2, shapes of BeF_2, BF_3, NH_4^+, PF_5, XeF_6, VSEPR theory – shapes of CH_4, NH_3, H_2O, BF_3, BrF_3, ICl_2^-. Molecular orbital theory – H_2, He_2^+, Be_2, N_2, O_2, O_2^-, O_2^{2-}(bond order, stability and magnetic properties to be discussed). **6 HRS**

1.3 Covalent character in ionic bonding-polarization concept, Fajan's rules. Effect of increasing covalency on the melting point of ionic compounds. Bond length, bond angle and bond energy. Polar and nonpolar molecules, dipole moment. Non covalent interactions: Hydrogen bond -(intramolecular and intermolecular type), anomalous properties of hydrogen flouride and water, hydrogen bonding in ammonia, alcohols, carboxylic acids and nitrophenols, importance of hydrogen bonding in biological molecules (DNA and protein folding), van der Waals forces in noble gases and molecular crystals. **6 HRS**

1.4 Metallic bond – band theory, classification into metals (ex: Li), semiconductors and insulators based on band theory, superconductors and their applications. **2 HRS**

UNIT II

Chapter 2 SILICATES **4 HRS**

Principles of silicate structure, structure of SiO_4^{4-}, classification of silicates– ortho (Willemite, zircon), pyro (thortveitite, hemimorphite) cyclic (beryl, benitoite), chain (pyroxene, tremolite), layer or sheet (talc, kaolinite) and three dimensional -Feldspar,Zeolites generalformula applications of zeolite as molecular sieve, base exchanger (in softening of water) ,water soluble silicates (sodium silicate).

Chapter 3: WATER POLLUTION **4 HRS**

Introduction, Parameters to determine water quality: – Colour, Turbidity, Conductivity, Acidity, Alkalinity and Hardness; Dissolved oxygen (DO), Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) and their measurement. Special Techniques for Water Treatment: Deionisation of water by ion exchange method, Desalination by (i) Electrodialysis and (ii) Reverse Osmosis.

Chapter 4: ORGANIC HALIDES **5 HRS**

Alkyl halides: Nomenclature and classification. Nucleophilic Aliphatic Substitution Reactions: Nucleophile, Leaving group, Duality of mechanism, S_N1 Reaction: Mechanism,

Kinetics, Energy Profile Diagram, stereochemistry (Racemisation), rearrangements (1,2 hydrogen shift only Example: 3-methyl-2-chlorobutane). S_N2 Reaction: Mechanism, Kinetics, Energy Profile and stereochemistry (Walden Inversion). Factors affecting S_N1 and S_N2 reactions: (i) nature of alkyl groups (Steric hindrance and stability of carbocations) (ii) nature of leaving groups (iii) strength of nucleophile and (iv) solvents (polar, protic, aprotic) and (v) concentrations. Elimination reactions – E_1 and E_2 mechanisms, Saytzeff rule. Substitution vs. elimination. S_N2 vs E2, S_N1 vs E1.

Aryl halides - relative reactivity of alkyl, allyl, vinyl and aryl halides towards nucleophilic substitution.

UNIT III

Chapter 5: AROMATIC HYDROCARBONS 10 HRS

Review of nomenclature of benzene derivatives, Kekule structure, resonance structure and molecular orbital picture of benzene.

Stability of benzene based on heat of hydrogenation. Hückel's aromaticity rule w. r. t. benzenoid (examples: benzene, naphthalene, anthracene and phenanthrene) and non benzenoid (examples: cyclopentadienyl anion, cycloheptatrienylcation); antiaromacity (Cyclobutadiene).

Aromatic electrophilic substitution reactions – General mechanism, mechanisms of chlorination, nitration, sulphonation and Friedel Craft's reaction: acylation and alkylation. Reactivity and orientation towards second substitution: ortho-para directors (toluene, chlorobenzene, phenol) and meta directors (Nitrobenzene) - activators and deactivators; hyperconjugation and resonance effects of these substituent groups, Hydrogenation of aromatic compounds: Birch reduction. Oxidation of side chain of toluene to benzaldehyde and benzoic acid, oxidation of naphthalene, anthracene and phenanthrene; Diels-Alder reaction of anthracene with (i) maleic anhydride (ii) 1,2-dichloroethene. Alkenyl benzenes: Styrene, *cis* and *trans*-stilbenes and their preparations. Biphenyl: Preparation by Ulmann reaction.

UNIT IV

Chapter 6: THERMODYNAMICS – 1 9 HRS

Definition of thermodynamic terms – types of variables – intensive and extensive, type of processes: isothermal, adiabatic, reversible and irreversible. *Review of First law of thermodynamics*, significance of internal energy and enthalpy. State functions – exact and inexact differentials, concept of heat and work, Derivation of expression for work done in reversible isothermal expansion, reversible adiabatic expansion of a gas, derivation of PV^{γ} = constant and $TV^{\gamma-1}$= constant. Problems. Heat capacity of gas at constant pressure and at constant volume and relation between the two. Problems. Derivation of Kirchoff's equation, Problems. Significance of bond energies and calculation (thermochemical values), Problems.

Chapter 7: LIQUID STATE 3 HRS

Intermolecular forces, surface tension- measurement using stalagmometer, viscosity- measurement using Ostwald's viscometer, effect of temperature and substituents on viscosity and surface tension of organic compounds.

UNIT V

Chapter 8: SOLUTIONS 8 HRS

Raoult's law, ideal and non-ideal solutions; completely miscible , partially miscible and immiscible pair of liquids, boiling point - composition curves and vapour pressure - composition curves; principles of fractional distillation, fractional distillation of completely miscible pair of mixtures; azeotropic mixtures, study of partially miscible pair of liquids, concept of upper and lower critical solution temperature, effect of addition of salt on CST of phenol and water, steam distillation and its applications. Nernst Distribution law - verification and application w.r.t Solvent extraction. Henry's law of gas solubility and its applications.

REFERENCES:

1. B. R. Puri, L.R. Sharma and M.S. Pathania, Principles of Physical Chemistry, 47th edition, 2017, Shoban Lal Nagin Chand and Co.
2. J. D. Lee, Concise Inorganic Chemistry. 5th edition, 2008, Wiley India Pvt. Ltd.
3. R. D. Madan, Modern Inorganic Chemistry, 2nd edition, 2002. S.Chand & Co.
4. R.T.Morrison, R.N.Boyd and S.K. Bhattacharjee, Organic Chemistry, 7th edition, 2010, Pearson Education.

5. A.K. Das, Environmental Chemistry with Green Chemistry, 2012, Books and Allied Publ.
6. T.W. Graham Solomons, Organic Chemistry, Global Edition – 2017.

I B.Sc., II Semester, Chemistry Practical – 2

DURATION: 3 HRS / WEEK **NO. OF UNITS: 15**

1. Determination of density (using specific gravity bottle) and viscosity of a liquid by time of flow method using Ostwald's viscometer
2. Determination of density (using specific gravity bottle) and surface tension of a liquid by number of drops method using a stalagnometer.
3. Determination of the percentage composition of binary liquid mixture by viscosity method.
4. Determination of heat of neutralisation of a strong acid with a strong base.
5. Determination of heat of solution of KNO_3 or NH_4Cl in water.
6. Determination of the Molar Mass by ebullioscopic method.
7. Determination of the degree of dissociation of an electrolyte by ebullioscopic method.
8. Determination of the amount of Dissolved Oxygen in water by Winkler's Method.
9. Determination of Total Organic Matter in water samples.
10. Determination of acidity and alkalinity of the given water sample.
11. Determination of Chlorinity and Salinity in a given water samples.

Repetition and Tests.

REFERENCES

1. P.K.Mani & A.O.Thomas, Text Book of Practical Chemistry, 4th edition, 1976, Scientific Publications.
2. M.J.Sienko, R.A.Plane.S.T.Marcus, Experimental Chemistry, 6th edition, 1985, McGraw-Hill Book Company.