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**No.AC.2(S)/486/16-17**

**Dated: 20.06.2017**

**NOTIFICATION**

**Sub:** Minor modification in the syllabus for Chemistry (Graduate) course from the academic year 2017-18.

**Ref:** 1. Decision of the Faculty of Science & Technology Meeting held on 03-03-2017.  
2. Decision of the Academic Council meeting held on 30-03-2017.

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The Board of Studies in Chemistry (UG) which met on 24-12-2016 has recommended to make some modifications in the existing syllabus of the B.Sc. Chemistry paper from the academic year 2017-18.

The Faculty of Science and Technology and the Academic Council at their Meetings held on 03-03-2017 and 30-03-2017 respectively have also approved the above said proposal and the same is notified.

The Chemistry paper of B.Sc. degree modified syllabus is annexed herewith.

The concerned may download the modified syllabus in the University Website i.e., [www.uni-mysore.ac.in](http://www.uni-mysore.ac.in).

Draft approved by the Registrar

**Sd/-**  
**Deputy Registrar (Academic)**

**To:**

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DOS in Physics, Manasagangotri, Mysore.
3. The Chairperson, BOS in Chemistry, DOS in Chemistry, Manasagangotri, Mysore.
4. The Chairperson, Department of Studies in Chemistry, Manasagangotri, Mysore.
5. The Director, College Development Council, Moulya Bhavan, Manasagangotri, Mysore.
6. The Principals of the Affiliated Colleges where UG Program is running in Science stream.
7. The Deputy/Asst.Registrar/Superintendent, AB and EB, University of Mysore, Mysore.
8. The P.A. to the Vice-Chancellor/Registrar/Registrar( Evaluation), UOM., Mysore.
9. Office file.

**UG CHEMISTRY WITH MINOR MODIFICATIONS AND CORRECTIONS**

| Sl. No   | Existing   | Modified  |
|--|--|---|
| <b>II Semester – Organic Chemistry Unit - III</b>    |  |   |
| 1  | <b>Alkenyl Benzenes:-Cis-----</b> (Any one method)   | <b>Alkenyl Benzenes:-Preparation of stilbene</b> (one method), Cis-trans isomers of stilbene  |
| <b>III Semester – Organic Chemistry Unit - I</b>     |  |   |
| 2  | <b>Organic halides:</b> ----- Saytzeff and Hoffmann elimination with mechanism --- [3 Hours]                                     | <b>Organic halides:</b> ----- Saytzeff rule ----- [2 Hours]   |
| <b>III Semester – Organic Chemistry Unit - II</b>    |  |   |
| 3  | <b>Aryl halides:</b> ----- [4 Hours]   | <b>Aryl halides:</b> ----- [3 Hours]  |
| 4  | <b>Organometallic Compounds:</b> [3 Hours]   | <b>Organometallic Compounds:</b> [2 Hours]  |
| <b>III Semester – Organic Chemistry Unit - III</b>   |  |   |
| 5  | <b>Monohydric Alcohols:</b> Preparation of alcohols by hydroboration and oxidation method-----victor meyer oxidation method----- | <b>Monohydric Alcohols:</b> Preparation of alcohols by Hydroboration-oxidation method-----Victor meyer and oxidation method-----  |
| <b>III Semester – Inorganic Chemistry Unit - III</b> |  |   |
| 6  | Boron Hydrates   | Boron Hydrides  |
| 7  | Diborane-Preparation, structure and uses   | Diborane-Preparation, properties (Oxidation lewis acidity and hydroboration) structure and uses   |
| <b>V Semester – Organic Chemistry Unit - III</b>     |  |   |
| 8  | <b>Green Chemistry:-Purpose-----</b> acetanilide   | <b>Green Chemistry:-Purpose.</b> Principles to be followed for green Chemistry, synthesis of Adipic acid, Catechol, Methyl methacrylate, Ibuprofen, Paracetamol and Furfural  |
| <b>V Semester – Organic Chemistry Unit - V</b>       |  |   |
| 9  | <b>Synthetic Polymers:-</b> Definition, vehicle---- vanillin   | <b>Synthetic Polymers:-</b> Definition, classification with examples, synthesis of Epoxy resin, Polyurethane, Melamine-formaldehyde resin and Bakelite                        |
| <b>V Semester – Inorganic Chemistry Unit - III</b>   |  |   |
| 10   | Polynuclear complexes Inner metallic complexes-----  | Polynuclear complexes Inner metallic complexes Applications of complexes: Cis platin in cancer therapy, Na <sub>2</sub> CaEDTA in treatment of heavy metals (Pb&Hg) poisoning |
| <b>V Semester – Inorganic Chemistry Unit - IV</b>    |  |   |
| 11   | Valence bond theory (5 Hours)  | Valence bond theory   |
| <b>V Semester – Inorganic Chemistry Unit - V</b>     |  |   |
| 12   | Biological role of alkali and alkaline earth metal ions with respect to Na <sup>+</sup> and Ca <sup>+2</sup> ions                | Biological role of alkali and alkaline earth metal ions with respect to Na <sup>+</sup> , K <sup>+</sup> and Ca <sup>+2</sup> , Mg <sup>+2</sup> ions                         |
| <b>VI Semester – Organic Chemistry Unit - IV</b>     |  |   |
| 13   | <b>Amino acids:-</b> Structure-----HOAt  | <b>Amino acids:-</b> Structure, classification with examples, peptide bond, N-protecting & C-protecting groups, peptide synthesis (Gly-Gly, Gly-Ala)                          |

|  |  |  |
|--|--|--|
| <b>VI Semester – Inorganic Chemistry</b> |  |  |
| <b>Unit - I</b>                          |  |  |
| 14                                       | <b>Silicones:</b> Definition ----- silicon resins (Preparation and uses) (6 Hours) | <b>Silicones:</b> Definition, nomenclature, preparation, (linear, cross linked and cyclic). Factors affecting the nature of silicon polymers, properties (Chemical and thermal stabilities, chemical properties) uses of silicon polymers. (5 Hours) |
| <b>VI Semester – Inorganic Chemistry</b> |  |  |
| <b>Unit - II</b>                         |  |  |
| 15                                       | <b>Paints:</b> Constituents -----titanium dioxide (5 Hours)                        | <b>Paints:</b> Constituents -----titanium dioxide (5 Hours)<br><b>Glass:</b> Composition and applications of borosilicate, optical, safety, fire and bullet proof glasses. Manufacture of soda Glass (6 Hours)                                       |
| 16                                       | <b>Reference Book</b>  | <b>An Introduction to Green Chemistry by V. Kumar</b>  |

# UNIVERSITY OF MYSORE

## SUBJECT: CHEMISTRY

REVISED SYLLABUS FOR B.Sc. COURSE UNDER SEMESTER SCHEME

DURATION OF THE COURSE – THREE YEARS – SIX SEMESTER

FROM THE ACADEMIC YEAR 2014-15

***(Minor Modifications From 2017-18)***

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### I SEMESTER

#### CHEMISTRY PAPER – I

CLASS DURATION – 03 HOURS PER WEEK

MARKS: Theory – 60 + Internal Assessment – 10 = 70

#### INORGANIC CHEMISTRY

**14 Hours**

#### UNIT-I

**Elements of quantum mechanics:** Wave mechanical concept of the atom, dual nature of electron, derivation of de-Broglie's equation. Heisenberg's uncertainty principle and its significance. Schrodinger wave equation-explanation of the terms therein (no derivation) Eigen values and functions, significance of  $\psi$  and  $\psi^2$ . Quantum numbers and their significance. Shapes of s, p and d orbitals. Effective nuclear charge, screening effect-based on Slater's rules (problems to be worked out). General energy level diagram of multi electron atom (up to  $n=4$ ). Pauli's exclusion principle, Hund's rule,  $(n+1)$  rule, Aufbau principle. Electronic configuration of elements (up to At. No. 40), stability of completely filled and half filled orbitals based on the concepts of pairing energy, promotional energy and symmetric charge distribution.

**[7 Hours]**

## UNIT-II

**Periodic Table and Periodicity:** Classification of elements into s, p, d, and f-blocks, cause of periodicity. Detailed discussion of the following periodic properties of elements with examples.

**1) Atomic radius:** Covalent, ionic, Vanderwaal's and crystal radii. Additive nature of covalent radii. Determination of ionic radii by Lande's method. Variation of covalent radii in a group and in a period- explanation for the observed trends. Comparison of the size of the atoms with the corresponding anions and cations, Variation of ionic radii in isoelectronic ions.

**2) Ionization enthalpy:** Successive ionization enthalpy, factors affecting ionization enthalpy, applications of ionization enthalpy. Variation in a group and in a period – explanation for the observed trends.

**3) Electron gain enthalpy:** Successive electron gain enthalpy variation of electron gain enthalpy in period and in a group- explanation for the observed trends.

**4) Electronegativity:** Variation of electronegativity in a group and in a period- explanation for the observed trends. Factors determining electro negativity (charge on the atom and hybridization). Pauling, Mulliken and Allred-Rochow scale of electronegativity. Applications of electronegativity.

[7 Hours]

## ORGANIC CHEMISTRY

14 Hours

### UNIT-I

**Introduction to organic chemistry-** Definition and importance of organic compounds to life and applications in food, fuels, textiles, dyes, drugs and cosmetics with examples. Nomenclature (IUPAC) of bifunctional, aliphatic and aromatic compounds.

[3 Hours]

### UNIT-II

**Basic Concepts in Organic Chemistry:** Generation, stability and reactions involving carbocations, carbanions, free radicals, nitrene and carbenes.

**Types of organic reactions:** Definition with examples of addition, substitution, elimination, isomerisation, condensation and rearrangement reactions.

**Hybridization:** Tetravalency of carbon,  $sp^3$ ,  $sp^2$  and  $sp$  – hybridization (in brief). Bond length, bond angle, bond energy, localized and delocalized chemical bonds – resonance and hyperconjugation effects.

**[4 Hours]**

### UNIT-III

**Alkanes:** Preparation by Corey-House reaction, conversion of alkanes to aromatic compounds via alkenes and alkynes- aromatization and pyrolysis.

**Alkenes:** Preparation of alkenes by Witting's reaction, Hoffmann's elimination, Stereoselectivity. Mechanism of electrophilic addition, oxymercuration, reduction, hydroboration – oxidation and epoxidation. Mechanism of oxidation with  $KMnO_4$  and  $OsO_4$ , ozonolysis. industrial applications of ethene and propene.

**Dienes:** Types, relative stabilities of dienes, conjugated dienes – 1,3 butadiene-structure, 1,2 and 1,4-addition reactions with  $H_2$  and halogens, Diel's Alder reaction with an example.

**Alkynes:** Methods of preparation – dehydrohalogenation, vicinal and gem dihalides, reactions of alkynes – Electrophilic additions with HCN,  $CH_3COOH$  and  $H_2O$  polymerization.

**[7 Hours]**

### PHYSICAL CHEMISTRY

**14 Hours**

#### NOTES:

- SI Units to be used
- Problems to be worked out and diagrams to be drawn whenever necessary

### UNIT I

**Gases:** Maxwell-Boltzmann distribution of molecular velocities (no derivation – assume equation) explanation. Effect of temperature on distribution of molecular velocities using distribution curve (graph). Boltzmann factor (significance and equation). Energy distribution as a function of temperature. Types of molecular velocities – average ( $u_{av}$ ) - root mean square velocity ( $u_{rms}$ ) - most probable velocity ( $u_{mp}$ ) – their definition and equations (no derivation). Relation between  $u_{av}$ ,  $u_{rms}$  and  $u_{mp}$  velocities of molecules and their calculations (based on temperature dependence).

**[4 Hours]**

## UNIT II

The critical phenomena – Andrew's experiments on  $\text{CO}_2$ , critical constants –  $T_c$ ,  $P_c$  and  $V_c$ . definitions- experimental determination of Critical temperature and Critical pressure by using Cagniard delaTour's apparatus. critical volume by Cailletes and Mathias method – Vander Waal's equation – relation between Vander Waal's Constants 'a' and 'b' and critical constants  $T_c$ ,  $P_c$  and  $V_c$  to be derived using isotherms of  $\text{CO}_2$ . Law of corresponding states and reduced equation of state (to be derived)

Liquefaction of gases – Principle underlying liquefaction of gases – Joule Thomson effect, Joule Thomson experiment – Show that Joule Thomson effect is an isoenthalpic process ( $\Delta H = 0$ ). Joule Thomson coefficient, Inversion temperature, definitions and its relation between Vander Waal's constants ('a' and 'b').

[4 Hours]

## UNIT III

Indicator – Definitions, types (acid-base, redox, adsorption indicators), examples for each type. Theory of indicators – Oswald's theory and Quinonoid theory – indicator constant – action of phenolphthalein and methyl orange in acid-base solutions – pH titration curves for strong acid vs strong base, weak acid vs strong base, weak base vs strong acid, choice of indicators in these types of titrations – color change and pH range. Universal indicator – definition.

**Adsorption:** Introduction, principle involved. Sorption, absorption and adsorption (statement, differences and examples) physical and chemical adsorption – definition and differences. Adsorption of gases on solids – factors which influence. Adsorption isotherms (definition) – mathematical expression for Freundlich's and Langmuir's adsorption isotherms. Applications of adsorption.

[6 Hours]

## II SEMESTER

### CHEMISTRY PAPER – II

CLASS DURATION – 03 HOURS PER WEEK

MARKS: Theory – 60 + Internal Assessment – 10 = 70

### INORGANIC CHEMISTRY

14 Hours

#### UNIT-I

**Chemical bonding-I: Ionic bond:** Factors that favor the formation of ionic bonds, Lattice energy, Born-Landé's equation (no derivation), Born-Haber cycle, setting up of Born-Haber cycle for 1:1 ionic solids. Numerical calculations of LE and EA based on Born-Haber cycle for 1:1 ionic solids, uses of Born-Haber cycle. Role of lattice energy and hydration energy and their importance in the context of stability and solubility of ionic solids.

**Covalent bond:** Factors favouring the formation of covalent bond (ionization energy, electron affinity, electronegativity, nuclear charge, inter nuclear distance and number of valence electrons). Valence bond approach – explanation with examples ( $H_2$ ,  $F_2$ ,  $HF$ ,  $O_2$  and  $N_2$ ) to illustrate valence bond approach. Sigma and Pi bonds – explanation by taking  $H_2$ ,  $O_2$  and  $N_2$  as examples.

Fajan's rules of polarization and their explanation. Bond length, bond order, bond energy and their significance, polarity of covalent bonds, polar and non-polar molecules, Dipole moment and polarity of molecules to be explained by taking  $HCl$ ,  $CO_2$ ,  $CCl_4$  and  $H_2O$  as examples.

[6 Hours]

#### UNIT-II

**Chemical bonding-II:** Hybridization-directional property and geometry of  $sp$ ,  $sp^2$ ,  $sp^3$ ,  $sp^3d$  and  $sp^3d^2$  hybrid orbitals taking  $BeCl_2$ ,  $BF_3$ ,  $SiCl_4$ ,  $PCl_5$  and  $SF_6$  as examples respectively. VSEPR theory with  $SO_2$ ,  $NH_3$ ,  $H_2O$ ,  $SF_4$  and  $ClF_3$  as examples.

**Coordinate bond:** Explanation with examples  $H_3O^+$ ,  $NH_4^+$ ,  $NH_3-BF_3$  molecule.

**Molecular Orbital Theory:** An elementary account of MOT, linear combination of atomic orbitals (no mathematical approach). Bonding and antibonding molecular orbitals, conditions for the combination, energy levels of molecular orbitals, Molecular orbital structures and bond orders of species like  $H_2$ ,  $He_2$ ,



He<sub>2</sub><sup>+</sup>, N<sub>2</sub>, O<sub>2</sub>, HF, LiH, and CO, Prediction of magnetic properties of these species.  
[6 Hours]

**Statistical treatment of results of quantitative analysis:** Classification of errors, accuracy, precision, minimization of errors (calibration of apparatus, running of blank determination, running parallel determination to be mentioned), significant figures and computation, mean and standard deviation (explanation with an example), distribution of random errors (explanation with the help of curve), reliability of results (F-test and t-test).  
[2 Hours]

## ORGANIC CHEMISTRY

14 Hours

### UNIT-I

**Organic Reagents:** One method of preparation and applications of acetic anhydride, benzoyl chloride, dimethyl sulphate, raney nickel and sodium ethoxide.  
[2 Hours]

### UNIT-II

Cycloalkanes: Definition, examples, relative stability Bayer's strain theory and its limitations. Sachse-Mohr's theory of strainless rings. Chair and boat conformations of cyclohexane and their stability. Conformations of cyclopentane.  
[3 Hours]

### UNIT-III

**Aromatic hydrocarbons:** Nomenclature of benzene derivatives, Huckel's rule with respect to benzenoids, (benzene, naphthalene, anthracene and phenanthracene) and non-benzenoid compounds (cyclopentadienyl anion, cycloheptadienyl cation) anti-aromaticity.

Aromatic electrophilic substitution – General mechanism, electronic interpretation of orientating influence of electron donating groups (-CH<sub>3</sub>, -Cl, -NH<sub>2</sub> and -OH groups) and electron withdrawing groups (-NO<sub>2</sub>, -CHO, -COOH and -SO<sub>3</sub>H groups) on electrophilic substitution reactions.

**Hydrogenation of aromatic compounds:** Birch reduction, side chain oxidation of toluene to benzaldehyde and benzoic acid. Resonating structures of benzene, naphthalene and anthracene. Diel's Alder reactions of anthracene with maleic anhydride.

**Biphenyls:** Preparation – Ullmann reaction.

**Alkenyl Benzenes:** Preparation of stilbene (one method), Cis-trans isomers of stilbene

[9 Hours]

# PHYSICAL CHEMISTRY

14 Hours

## NOTES:

- SI Units to be used
- Problems to be worked out and diagrams to be drawn whenever necessary

## UNIT 1

**Liquid mixtures:** Classification of binary mixtures – partially miscible, completely miscible and completely immiscible pairs of liquids (explanation with examples for each type). Raoult's law, definition of ideal and non-ideal solutions based on Raoult's law.

**Partially miscible liquids:** Critical solution temperature (CST) – types – phenol-water system, triethylamine-water system, nicotine-water system (mutual solubility temperature (MST) vs composition curves to be drawn). Effect of addition of non-volatile solute on CST. Binary mixtures of completely miscible liquids.

Vapour pressure – definition, vapor pressure – composition diagrams and boiling point – composite diagrams. Classification into the types – obeying Raoult's law (type I), showing positive deviation from Raoult's Law (type II) and showing negative deviation from Raoult's Law (type III) – examples for each type.

**Principles of fractional distillation:** Fractional distillation of type I, type II and type III liquid mixtures (with examples). Azeotropic mixtures (definition).

Binary mixtures of completely immiscible liquids (with examples), weight fraction of distillates (no derivation), principle of distillation, applications (numerical problem on weight fractions of components).

[5 Hours]

## UNIT II

**Colligative Properties:** Concept of vapour pressure, variation of vapour pressure with temperature. Definition of boiling point and freezing point, effect of dissolution of solute on the vapour pressure of the solvent. Lowering of vapour pressure. Raoult's law – relation between relative lowering of vapour pressure and molar mass (to be derived). Determination of relative molar mass of solute by dynamic method. Elevation of boiling point and its relation to lowering of vapour pressure and molar mass (to be

derived). Ebullioscopic constant of the solvent and its relation to the boiling point (only equation). Determination of molar mass of the solute by Walker-Lumsden method. Depression in freezing point and its relation to lowering of vapour pressure and molar mass (to be derived). Cryoscopic constant and its relation to the melting point (equation). Determination of molar mass of a non-volatile solute by Beckmann's method (problems to be worked out).

**[5 Hours]**

### **UNIT III**

Semi permeable membrane – natural and artificial, preparation of copper ferrocyanide membrane by Morse-Frazer method. Definition of osmosis, osmotic pressure (mention application), determination of osmotic pressure by Berkley-Hartley's method, laws of osmotic pressure analogy with gas laws, determination of molar mass from osmotic pressure measurements (relation to be derived), isotonic solutions, plasmolysis.

**[4 Hours]**

## III SEMESTER

### CHEMISTRY PAPER – III

CLASS DURATION – 03 HOURS PER WEEK

MARKS: Theory – 60 + Internal Assessment – 10 = 70

### INORGANIC CHEMISTRY

14 Hours

#### UNIT-I

**Metallic bond:** Definition, factors favouring the formation of metallic bond, Band theory, explanation of electrical conductance of metals, semiconductors (n- and p-type), Insulators and Superconductors (explanation and applications with suitable examples).

**Hydrogen bonding:** Types of hydrogen bonding, conditions for the formation of H-bond. Hydrogen bonding in HF, H<sub>2</sub>O, NH<sub>3</sub>, alcohols, carboxylic acids and nitrophenols. Appropriate anomalous properties like physical state, boiling point and solubility. Structure of ice. Theories (or nature) of hydrogen bond (electrostatic approach, VBT and MOT treatments) [5 Hours]

#### UNIT-II

**Metal carbonyls:** Definition, classification with examples, nature of M-CO bonding in carbonyls. Preparation, properties and structures of mono nuclear and binuclear metal carbonyls-Ni(CO)<sub>4</sub>, Cr(CO)<sub>6</sub>, Fe(CO)<sub>5</sub>, Mn<sub>2</sub>(CO)<sub>10</sub>, Co<sub>2</sub>(CO)<sub>8</sub>. Applications of EAN rule to mononuclear metalcarbonyls. [3 Hours]

#### UNIT-III

**Boron:** Boron hydrides – diborane-preparation, properties (Oxidation, lewis acidity and hydroboration) structure and uses.

**Carbon:** Fullerenes – production, structure of C<sub>60</sub> and C<sub>70</sub>. Diamond, graphite – properties and structure.

**Silicon:** Structure of silica. Silicates – types and structure with one example for each type.

**Nitrogen:** Preparation, properties, structure and applications of hydrazine, hydroxyl amine and nitrogen trichloride.

**Sulphur:** Preparation, properties, structures and applications of thionyl chloride, sulphuryl chloride and SF<sub>6</sub>.

**Halogens:** Bleaching powder – preparation, properties and structure.

**Pseudo halogens:** Preparation, properties and structure of cyanogen and thiocyanogen (any one method of preparation and any three properties to be discussed). [6 Hours]

## ORGANIC CHEMISTRY

14 Hours

### UNIT-I

**Organic halides:** Alkyl halides: isomerism and classification, elimination reaction: dehydrohalogenation. Saytzeff rule, Nucleophilic substitution reaction. S<sub>N</sub><sup>1</sup> and S<sub>N</sub><sup>2</sup> with energy profile diagram. Effect of nature of alkyl groups, nature of leaving groups, nucleophiles and solvents. [3 Hours]

### UNIT-II

**Aryl halides:** Relative reactivity of alkyl, allyl, vinyl and aryl halides towards nucleophilic substitution reactions. Generation of benzyne-trapping with dienes (furan and anthracene). [3 Hours]

**Organometallic compounds:** Definition with example, organo zinc compounds – preparation of diethyl zinc and its applications.

**Organolithium Compounds:** Preparation and synthetic applications. [2 Hours]

### UNIT-III

**Alcohols:** Definition and classification.

**Monohydric alcohols:** Preparation of alcohols by Hydroboration-oxidation method. Hydration of alkenes. Distinction tests between 1°, 2°, and 3° alcohols by Victor Meyer and oxidation method. Conversion of 1° to 2°, 2° to 3° and 1° to 3° alcohols. Dehydration of 1°, 2°, 3° alcohols and comparison of their rates.

**Dihydric alcohols:** Glycol – preparation from vicinal dihalides and uses. Pinacoles – synthesis, mechanism of pinacol-pinacolone rearrangement

**Trihydric alcohols:** Glycerol, synthesis from propene, reactions with  $\text{HNO}_3$ ,  $\text{H}_2\text{SO}_4$ , oxalic acid and HI. Uses of glycerol. [4 Hours]

## UNIT-IV

**Phenols:** Definition, classification with examples, acidity of phenols, effect of substituents on acidity of phenols. Mechanism of Reimer-Tiemann reaction and Kolbe reaction. [3 Hours]

## PHYSICAL CHEMISTRY

14 Hours

### NOTES:

- SI Units to be used
- Problems to be worked out and diagrams to be drawn whenever necessary

## UNIT I

**Polymers:** Introduction, monomer, repeating units, types (linear, branches and network) with examples, degree of polymerization, classification (arrangement and shape) with examples, polymerization reaction (addition and condensation), molar masses of polymers – types (number average and mass average), determination of molar mass (viscosity and osmotic pressure method) (Numerical problems).

[5 Hours]

## UNIT II

**Ionic equilibria:** Ionic equilibria in aqueous solutions, strong and weak electrolytes – definition and examples. Ostwald's dilution law (to be derived) and its limitations (numerical problems). Activity and activity coefficients – definition and their relation. Mean ionic activity coefficients – ionic strength – determination and its calculation. Debye-Huckel theory of strong electrolytes (relaxation time effect, electrophoretic effect and viscous effect). Debye-Huckel-Onsagar equation (no derivation), Debye-Huckel Limiting equation for activity coefficients (no derivation). Solvent system concept of acids and bases. Role of solvents in altering strengths of acids and bases. Hydrolysis of salts – derivation of hydrolysis constant and degree of hydrolysis of the salt of weak acid and weak base (ammonium acetate), effect of

temperature on degree of hydrolysis.

[5 Hours]

### UNIT III

**Distribution Law:** Nernst distribution law in liquid-liquid systems, distribution coefficient, statement of Nernst distribution law – verification of distribution law taking distribution of  $I_2$  in  $H_2O$  and  $CCl_4$  – limitations of the law, conditions for the validity of distribution law, association of the solute in one of the solvents, dissociation of the solute in one of the solvents, application of distribution law with respect to solvent extraction process (numerical problems) [4 Hours]

## IV SEMESTER

### CHEMISTRY PAPER – IV

CLASS DURATION – 03 HOURS PER WEEK

MARKS: Theory – 60 + Internal Assessment – 10 = 70

### INORGANIC CHEMISTRY

14 Hours

#### UNIT-I

**Noble gases:** Isolation from air by Rayleigh's method, preparation, separation of Noble gases-Dewar's method. Preparation, Structure and applications of compounds of Xenon and Krypton ( $XeF_2$ ,  $XeOF_2$ ,  $XeO_3$ ,  $KrF_2$ ,  $KrF_4$ ,  $KrO_3$   $XH_2O$ -one method of preparation for each), Clathrates (explanation with suitable examples, essential conditions for the formation and uses).

**Non-aqueous solvents:** Liquid ammonia-reasons for the solvent properties, typical reactions- solubility of alkali metals; acid-base, precipitation, ammonolysis, Ionization of weak acids, advantages and disadvantages. Liquid  $SO_2$ -reasons for the solvent properties, typical reactions-acid-base, solvolysis, precipitation, amphoteric and redox

**HSAB:** Classification of acids and bases as Hard and Soft. Pearson's HSAB concept, acid-base strength, hardness and softness, symbiosis. [7 Hours]

## UNIT-II

**Nuclear chemistry:** Fundamental particles of nucleus- nucleons, isotopes, isobars and isotones (definition with suitable examples), Nuclear forces (brief explanation), nuclear stability-n/p ratio, Mass defect, Binding energy, Inner structure of nucleus- Liquid drop model, Nuclear fission- (definition with suitable examples), Calculation of energy release in nuclear fission, modes of release of fission energy (uncontrolled and controlled).

Plutonium as a fissionable material (Plutonium bomb), nuclear fusion and its advantages over nuclear fission reactions, hydrogen bomb, nuclear transmutation-artificial radioactivity. Detection and measurement of radioactivity – G. M. counter. Cyclotron, Nuclear reactor, Breeder reactor, Q values of nuclear reactions. Uses of radio isotopes – tracer technique, agriculture, medicine, food preservation and dating (explanation). Separation of uranium isotopes – Laser irradiation method (atomic and molecular routes). [7 Hours]

## ORGANIC CHEMISTRY

14 Hours

### UNIT-I

**Ethers:** Nomenclature, Williamson ether synthesis, reactions – cleavage and auto-oxidation-Ziesel's method.

**Epoxides:** Synthesis by Darzen's method. Acid and base catalyzed opening of epoxides.

**Crown ethers:** Introduction with examples.

[3 Hours]

### UNIT-II

**Carbonyl Compounds:** Distinction between aldehydes and ketones – oxidation and reduction method. Addition of alcohols- formation of hemiacetal and acetal. Condensation with  $\text{NH}_2\text{OH}$  and 2,4-DNP. Mechanism of aldol condensation, Perkins reaction, Cannizzaro reaction, Claisen condensation, Knoevenagel reaction. [4 Hours]



## UNIT-III

**Carboxylic acids:** Definition, classification with examples. Synthesis by Arndt-Eistert reaction, resonance structure of carboxylate ion and its stability. Effect of substituents on acidity of aliphatic and aromatic carboxylic acids.

**Hydroxy acids:** Synthesis of lactic, citric and tartaric acids. One method each and their importance. Effect of heat on  $\alpha$ ,  $\beta$ ,  $\gamma$ -hydroxy acids. [3 Hours]

## UNIT-IV

**Amines:** Definition, classification with example. Separation of amine mixture by Hinsberg's method using toluene sulphonyl chloride. Distinction tests for 1°, 2°, 3° amines (acetylation and Hoffmann's exhaustive methylation. Action of nitric acid on different amines. Both aliphatic and aromatic 1°, 2°, 3° amines, basicity of amines, effect of substituents on basicity of aliphatic and aromatic amines. Hoffmann-Martius rearrangement.

**Diazonium Compounds:** preparation, mechanism of preparation and synthetic applications of benzene diazonium chloride. Conversion to phenol, halobenzene, phenyl hydrazine and coupling reaction. [4 Hours]

## PHYSICAL CHEMISTRY

14 Hours

### NOTES:

- SI Units to be used
- Problems to be worked out and diagrams to be drawn whenever necessary

## UNIT I

**Second law of thermodynamics:** Limitations of First Law of Thermodynamics – need for II Law of thermodynamics, spontaneous, non-spontaneous and equilibrium processes (definitions and examples for each), different ways of stating II Law, heat engine (example) Carnot cycle, efficiency of Carnot cycle (derivation), concept of entropy – definition and physical significances of entropy – criteria of spontaneity in terms of entropy change, statements of II law in terms of entropy (numerical problems to be worked out on entropy and efficiency of Carnot engine)

**Free energy:** Helmholtz and Gibb's free energy – their definitions and their relationship, Gibb's – Helmholtz equation at constant pressure and volume (derivations), thermodynamic criteria of equilibrium and spontaneity, variation of free energy with temperature and pressure, Clausius – Clapeyron equation (differential form to be derived), integrated form of Clausius – Clapeyron equation (to be assumed) and its applications (enthalpy of vapourization, boiling point and freezing point at different temperatures), (numerical problems on these applications), Van't Hoff's reaction isotherms and isochore equations (to be derived). **[5 Hours]**

## UNIT II

**Elementary Quantum Mechanics:** black body radiation – Planck's Law, Photoelectric effect, Compton effect, Schrodinger's wave equation (no derivation) and its importance, physical interpretation of wave function, particle in one dimensional box (no derivation), Hamiltonian operator.

**[5 Hours]**

## UNIT III

**Physical Properties and chemical constitution:** Additive and constitutive properties, properties of liquids – viscosity, definition of coefficient of viscosity, factors affecting viscosity – temperature, size, weight, shape of molecules, intermolecular forces, determination of viscosity of liquids by Ostwald's method.

**Surface tension:** Definition, effect of temperature on surface tension, effect of solute on surface tension, determination of surface tension of liquids using stalgmometer.

**Parachor:** Definition – Sugden equation, calculation of parachor and its application with respect to structural elucidation of benzene and quinone, numerical problems based on surface tension, viscosity and parachor applications. **[4 Hours]**

## V SEMESTER

### CHEMISTRY PAPER – V

#### INORGANIC CHEMISTRY

CLASS DURATION – 02 HOURS PER WEEK

MARKS: Theory – 60 + Internal Assessment – 10 = 70

28 Hours

#### UNIT I

**Chemistry of transition elements:** Position in the periodic table, electronic configuration, general characteristics- atomic and ionic radii, ionization energy, variable oxidation states, spectral properties, redox potentials, colour and magnetic properties, catalytic activity, complex formation and interstitial compounds formation (3d, 4d and 5d series).

**Chemistry of inner transition elements:** Electronic configuration and position in the periodic table, oxidation states, spectral properties, colour and magnetic properties, complex formation and ionic radii, lanthanide contraction – cause and its consequences. General survey of actinides – comparison with lanthanides, transuranic elements. **[5 Hours]**

**Ion-exchange:** Introduction, action of ion exchange resins – cation exchange and anion exchange resins, exchange of inorganic ions, ion exchange capacity, separation of lanthanides by ion- exchange method.

**[2 Hours]**

#### UNIT II

**Gravimetry:** Introduction to gravimetric analysis – precipitation methods (various steps involved to be discussed), advantages of gravimetric analysis, purity of the precipitates, co-precipitation and post-precipitation, conditions of precipitation, precipitation from homogeneous solution (hydroxides and sulphates), washing and ignition of precipitate (general discussion only). Electro-gravimetric analysis- estimation of copper.

**Organic precipitants:** Advantages of organic precipitants over inorganic precipitants, DMG, 8-hydroxy quinoline (Oxine), 1,10-phenanthroline and EDTA. Structure of  $\text{Ni}^{2+}$ -DMG and  $\text{Mg}^{2+}$ -oxine complexes.

**[5 Hours]**

## UNIT III

**Coordination Chemistry:** Ligands, classification of ligands and chelation, nomenclature of co-ordination compounds, physical methods in the study of complexes – change in conductance, colour and pH. Stability of complexes – stability constant, a brief outline of thermodynamic stability of metal complexes, factors affecting the stability of complexes. Polynuclear complexes, inner metallic complexes.

Applications of complexes: Cis platin in cancer therapy,  $\text{Na}_2\text{CaEDTA}$  in treatment of heavy metals (Pb&Hg) poisoning

**Isomerism in co-ordination complexes:** Stereo-isomerism – Geometrical and optical isomerism exhibited by co-ordination compounds of co-ordination number 4 and 6. **[6 Hours]**

## UNIT IV

**Metal-ligand bonding in transition metal complexes:**

**Valence bond theory:** Salient features, formation of octahedral complexes on the basis of VBT, outer and inner orbital octahedral complexes-  $[\text{Fe}(\text{CN})_6]^{4-}$ ,  $[\text{Fe}(\text{CN})_6]^{3-}$ ,  $[\text{Co}(\text{CN})_6]^{3-}$ ,  $[\text{CoF}_6]^{3-}$ ,  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$  and  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ . Formation of tetrahedral and square planar complexes on the basis of VBT –  $[\text{Ni}(\text{CN})_4]^{2-}$ ,  $[\text{Cu}(\text{NH}_3)]^{2+}$ ,  $[\text{Zn}(\text{NH}_3)_4]^{2+}$  and  $[\text{Ni}(\text{CO})_4]$ , limitations of VBT.

**Crystal field theory:** Important features of crystal field theory, crystal field splitting of d-orbitals in tetrahedral, octahedral and square planar complexes, crystal field stabilization energy (CFSE), factors affecting the magnitude of  $\Delta_o$ , (nature of ligand, oxidation state of the metal ion, size of the orbitals, geometry of the complex), high spin (HS) and low spin (LS) complexes, magnetic properties of metal complexes based on crystal field theory- $[\text{Co}(\text{NH}_3)_6]^{3+}$ ,  $[\text{CoF}_6]^{3-}$ ,  $[\text{Fe}(\text{CN})_6]^{4-}$ ,  $[\text{Fe}(\text{CN})_6]^{3-}$  and  $[\text{Ni}(\text{CN})_4]^{2-}$ . Magnetic susceptibility, measurement of magnetic moment by Gouy's method. Limitations of CFT.

**Ligand field theory:** Evidences for metal ligand covalent bonding in complexes. **[8 Hours]**

## UNIT V

**Bio-inorganic chemistry:** Essential and trace elements in biological process, metalloporphyrins with special reference to haemoglobin and myoglobin, Biological role of alkali and alkaline earth metal ions with respect to  $\text{Na}^+$ ,  $\text{K}^+$  and  $\text{Ca}^{+2}$ ,  $\text{Mg}^{+2}$  ions [2 Hours]

## V SEMESTER

### CHEMISTRY PAPER – VI

### ORGANIC CHEMISTRY

CLASS DURATION – 02 HOURS PER WEEK

MARKS: Theory – 60 + Internal Assessment – 10 = 70

28 Hours

## UNIT-I

**Carbohydrates:** Definition and importance, classification based on composition with examples-reducing and non-reducing sugars.

**Monosaccharides:** Glucose: reactions of glucose (with  $\text{H}_2\text{N-OH}$ ,  $\text{HCN}$ ,  $\text{C}_6\text{H}_5\text{NHNH}_2$ ,  $\text{Br}_2$  water, Conc.  $\text{HNO}_3$ , reductions with  $\text{HI/red P}$ , methanols, (dry  $\text{HCl}$ ), acetic anhydride and reduction reactions.

**Structural elucidation of glucose:** Open chain structure, configuration, drawbacks of open chain structure, ring structure – Fisher and Haworth structure. Determination of ring size by methylation method. Fischer and Haworth structures of fructose, galactose and mannose.

Conversion reactions – 1. Ascending (Kiliani's synthesis) 2. Descending (Wohl's degradation) 3. Aldose to ketose 4. Ketose to Aldose 5. Epimerisation

**Disaccharides:** Structural elucidation of sucrose, structural formulae of maltose and lactose (Haworth structure).

**Polysaccharides:** Partial structural formulae of starch, cellulose, glycogen and their uses.

[5 Hours]

## UNIT-II

**Stereochemistry:** Introduction, definition, elements of symmetry (plane, centre, simple axes and alternative axes), asymmetry and dissymmetry, Chirality, designation of configuration – R-S notation. Optical activity – explanation – cause of optical activity (non-super impossibility). Enantiomers and diastereomers optical isomerism in tartaric acid and biphenyls, racemisation, resolution, methods of resolution (Chemical and biochemical methods) Walden inversion, asymmetric synthesis (partial and absolute).

**Geometrical isomerism:** Definition with example, designation of cis-trans and E-Z notations with examples. Geometrical isomerization of aldoximes and ketoximes, Beckmann rearrangement.

**[5 Hours]**

## UNIT-III

**Green Chemistry:** Purpose, Principles to be followed for green Chemistry, synthesis of Adipic acid, Catechol, Methyl methacrylate, Ibuprofen, Paracetamol and Furfural **[2 Hours]**

## UNIT-IV

**Active methylene compounds:** Definition, ethyl acetoacetate, preparation and keto-enol tautomerism in ethyl acetoacetate-its evidence.

**Synthetic applications:** Acid hydrolysis, ketonic hydrolysis, mono carboxylic acids, dicarboxylic acids-succinic acid, adipic acid, antipyrine, uracil, acetyl acetone, crotonic acid and cinnamic acid.

**[3 Hours]**

## UNIT-V

**Synthetic Polymers:** Definition, classification with examples, synthesis of Epoxy resin, Polyurethane, Melamine-formaldehyde resin and Bakelite

**[2 Hours]**

## UNIT-VI

**Dyes:** Colour and constitution, chromophore - auxochrome theory, classification of dyes based on applications with examples, synthesis of indigo and malachite green, structural elucidation of alizarin and its synthesis. **[2 Hours]**

**Terpenes:** Definition, isoprene rule, classification, isolation (solvent extraction and steam distillation) structural elucidation of citral and its synthesis, structural formulae of  $\alpha$ -terpenoids, camphor and menthol. **[3 Hours]**

**Natural Pigments:** Introduction to anthocyanins, structural formulae and their importance of anthocyanins,  $\beta$ -carotene and haemoglobin. **[2 Hours]**

## UNIT-VII

**Chromatography:** Paper: introduction to ascending, descending and circular,  $R_f$  value and its applications

**TLC:** Introduction and applications

**Column Chromatography:** Introduction, principle and experimental details and applications

**Gas Chromatography:** Introduction, apparatus, programmed temperature gas chromatography, quantitative analysis of GLC

**HPLC:** Introduction, schematic diagram of instrumentation and application. **[4 Hours]**

## V SEMESTER

### CHEMISTRY PAPER – VII

#### PHYSICAL CHEMISTRY

CLASS DURATION – 02 HOURS PER WEEK

MARKS: Theory – 60 + Internal Assessment – 10 = 70

28 Hours

Class duration: 2 Hours per week

Marks: Theory = 60 + Internal Assessment = 10 (Total = 70)

#### NOTES:

- SI Units to be used
- Problems to be worked out and diagrams to be drawn whenever necessary

#### UNIT I

**Crystallography:** Elements of symmetry – plane, axis and centre, elements of symmetry in cubic crystals, law of rational indices – Weiss and Miller indices, lattice planes in cubic crystals. Crystal lattice and unit cell, types of Lattice – Bravais lattices, X-Ray diffraction and Bragg's Law (to be derived), determination of crystal structure of rock salt by rotating crystal method using Bragg's spectrometer, application of X-ray studies – distance between lattice planes, density of crystals, determination of Avogadro Number (numerical problems on applications).

**Liquid Crystals:** Definition, classification of thermotropic liquid crystals into smectic and nematic with examples-molecular arrangement of these and their uses. **[8 Hours]**

#### UNIT II

**Spectrophotometry and photochemistry:** Lambert – Beer's law – statement and mathematical form (to be derived). Molar extinction coefficient – definition – spectrophotometer – construction and working, its application.

Laws of photochemistry – Grotthus-Draper law of photochemical activation and Einstein's law of photochemical equivalence, quantum efficiency, reasons for low quantum yield (HBr formation as example) and high quantum yield (HCl formation as example), actinometry – Uranyl oxalate actinometer.



**Photophysical processes:** Definition with examples – photosensitization (eg. photosynthesis in plants), photo inhibition, fluorescence, phosphorescence, chemiluminescence and bioluminescence with examples. Determination of absorbed intensity – schematic diagram of apparatus used. Detectors – thermopile, photoelectric cell and actinometer (Uranyl oxalate).

**Radiation Chemistry:** Definition, primary and secondary stages in radiochemical reactions, ionic yield, energy yield, comparison with photochemistry, units of radiation – rad, gray and roentgen, Dosimeter – Fricke dosimeter, theories of radiolysis – Lind's and EHT theories. Radiolysis of water vapour, benzene and acetic acid.

**[8 Hours]**

### UNIT III

**Molecular Spectroscopy:** Regions of spectra, types of spectra, microwave spectra – rotational spectra of diatomic molecules, moment of inertia (expression to be derived). Expression for rotational energy, selection rule and transition, calculation of bond length, IR Spectra – vibrational spectra of diatomic molecules – force constant (no derivation), expression for vibrational energy, zero point energy, selection rule and transitions. Vibrational modes of polyatomic molecules taking H<sub>2</sub>O and CO<sub>2</sub> molecules as examples. Applications of IR spectroscopy (mention).

NMR Spectroscopy: Introduction – spin number, chemical shift, instrumentation, NMR spectra of ethyl alcohol – low and high resolution, applications (mention).

**[8 Hours]**

### UNIT IV

**Raman Spectra:** Concept of polarizability, pure rotation, vibration (qualitative study) stoke's and antistoke's lines, selection rule, applications (mention)

**Electronic Spectra:** Potential energy curves for bonding and antibonding molecular orbitals, band theory, electronic transitions, qualitative description of non-bonding orbitals and transition between them. Selection rule and Franck Condon principle.

**[4 Hours]**

## VI SEMESTER

### CHEMISTRY PAPER – VIII

#### INORGANIC CHEMISTRY

CLASS DURATION – 02 HOURS PER WEEK

MARKS: Theory – 60 + Internal Assessment – 10 = 70

28 Hours

#### UNIT I

**Inorganic polymers:** Definition – examples, general properties, comparison with organic polymers, glass transition temperature

**Silicones:** Definition, nomenclature, preparation (linear, cross-linked and cyclic). Factors affecting the nature of silicon polymers, properties (chemical and thermal stabilities, chemical properties) uses of silicon polymers,

**Phosphazenes:** Definition, types, structures, preparation, properties and uses. Crystalline polymetaphosphates – Maddrell's and Kuroll's salts – properties and uses. Nature of bonding in phosphazenes.

**Fluorocarbons:** Definition, examples, preparation, properties and uses of Freon-12, Freon-22, PTFE and poly per fluorovinyl chloride.

[5 Hours]

#### UNIT II

**Abrasives:** Definition, classification with examples – hardness, manufacture and applications of carborundum, alundum and tungsten carbide.

**Refractories:** Definition, properties, classification with examples. Different steps involved in the manufacture of refractories. Applications of refractories.

**Explosives:** Definition, classification with examples, characteristics of explosives. Preparation and uses of dynamite, cordite and RDX.

**Paints:** Constituents and their functions, manufacture of lithopone and titanium dioxide.

**Glass:** Composition and applications of borosilicate, optical, safety, fire and bullet proof glasses.  
Manufacture of soda Glass

[6 Hours]

### UNIT III

**Fuels:** Definition, classification with examples – characteristics, calorific value, determination of calorific value of a solid or liquid fuel. Applications of gaseous fuels. Compressed natural gas, water gas, producer gas and LPG – their production, composition and applications

**Propellants:** Definition, characteristics, classification and applications.

[4 Hours]

### UNIT IV

**Fertilizers:** Definition and classification, manufacture of nitrogenous fertilizers – CAN and urea. Phosphatic fertilizers – calcium dihydrogen phosphate, NPK type fertilizers. [2 Hours]

### UNIT V

**Metallurgy:** Types of metallurgy: Pyrometallurgy: Extraction of Nickel from sulphide ore – general metallurgy followed by Mond's process (purification), manganese from oxide ores – reduction by the Aluminothermite process – refining by electrolytic process.

**Hydrometallurgy:** Extraction of gold from native ore by cyanide process and refining by quartation process.

**Electrometallurgy:** Extraction of lithium by fusion method followed by electrolysis of lithium chloride.

**Powder metallurgy:** Importance, metal powder production and applications, production of tungsten powder. Extraction of (1) Thorium from monazite sand – purification by iodine method, (2) uranium from pitch blende – production of  $U_3O_8$  by carbonate method,  $U_3O_8$  to  $UO_2$  by reduction,  $UO_2$  to U by fluoride method. [8 Hours]

### UNIT-VI

**Nanotechnology:** Definition, uses and nature of nanotechnology, **Nanomaterials**-definition, properties and applications, **Carbon nanotubes**- definition, types, methods of preparation (mention), properties and industrial applications of carbon nanotubes, **Nanowires**-definition, types, production of crystalline

nanowires by vapour-liquid-solid synthesis method, applications of nanowires.  
[3 Hours]

## VI SEMESTER

### CHEMISTRY PAPER – IX

#### ORGANIC CHEMISTRY

CLASS DURATION – 02 HOURS PER WEEK

MARKS: Theory – 60 + Internal Assessment – 10 = 70

28 Hours

#### UNIT-I

**Heterocyclic Compounds:** Definition, classification with examples, synthesis of furan, thiophene, pyrrole, pyridine, indole (Fischer method) quinoline (Skrap's synthesis with mechanism), isoquinoline, pyrimidine (one method each), aromaticity and basicity of pyrrole and pyridine. Electrophilic substitution reactions of pyrrole and pyridine.

**Uric acid:** Elucidation of structure and synthesis by Fischer's method, conversion of uric acid to purine and caffeine

**Alkaloids:** Definition, classification based on heterocyclic rings-isolation, synthesis and structural elucidation of nicotine and morphine, physiological importance of alkaloids.

[8 Hours]

#### UNIT-II

**Vitamins:** Definition, classification, structural elucidation and synthesis of Vit-A, Synthesis of Vit-C, structural formulae of Vit B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, calciferol, E and K and their importance.

**Hormones:** Definition, classification, synthesis of adrenaline, thyroxine, structural formulae of estradiol, progesterone and testosterone and their importance.

**Drugs:** Chemotherapy and chemotherapeutic agents, definition of drugs, types of drugs, antipyretics, analgesics, anesthetics, sedatives, narcotics, antiseptics, antibacterials, antibiotics, antimalarials and

sulpha drugs with examples. Synthesis of paracetamol, sulphanilamide, sulphaguanidine.

**[8 Hours]**

### UNIT-III

#### Special techniques in organic synthesis:

- Polymer supported reagents – introduction, properties of polymer support-advantages of polymer support reagents, choice of polymers, types and applications.
- Phase transfer catalysis – introduction, definition, types, preparation, mechanism and advantages.
- Microwave induced organic synthesis – introduction, reaction vessel, reaction medium, advantages, limitations, precaution and applications.
- Sonochemistry – use of ultra sound in organic synthesis, introduction, instrumentation, physical aspects, types and applications. **[4 Hours]**

### UNIT-IV

**Amino acids:** Structure, classification with examples, peptide bond, N-protecting & C-protecting groups, peptide synthesis (Gly-Gly, Gly-Ala) **[2 Hours]**

### UNIT-V

#### Spectroscopy of organic compounds:

**UV-visible spectroscopy:** Introduction, chromophores and auxochrome, blue shift and red shift, graphical representation of spectra of 1,3-butadiene, benzene and lycopene. Influence of conjugation on UV absorption-comparison of UV spectra of acetone and methylvinyl ketone

**IR-Spectroscopy:** Introduction, stretching frequency of –OH (free and H-bonded), alkyl –C-H, C=C, C=C, C-C, C=O and C-O groups (by taking suitable examples). Graphical representation of IR spectra of benzoic acid and methyl benzoate

**NMR Spectroscopy:** Basic principles of proton magnetic resonance, nuclear magnetic spin quantum number I, influence of the magnetic field on the spin of nuclei, spin population, saturation using radio frequency, nuclear magnetic resonance-chemical shift ( $\delta$  value), uses of TMS reference, nuclear shielding effects, equivalent and non-equivalent protons, spin-spin splitting and coupling.

Applications of NMR spectroscopy to simple organic molecules (like ethyl alcohol, ethane, propane, ethylene, methylamine, aniline, benzene, toluene, acetone, acetophenone, methyl cyanide and other simple molecules. **[6 Hours]**

## VI SEMESTER

### CHEMISTRY PAPER – X

#### PHYSICAL CHEMISTRY

CLASS DURATION – 02 HOURS PER WEEK

MARKS: Theory – 60 + Internal Assessment – 10 = 70

**28 Hours**

#### NOTES:

- SI Units to be used
- Problems to be worked out and diagrams to be drawn whenever necessary

### UNIT I

**Electrochemistry-I:** Introduction, conductance – specific conductance, equivalent conductance and molar conductance – their definitions and SI units. Conductance cell and cell constant. Determination of equivalent conductance by meter – bridge method, ionic mobility, ionic conductance, Kohlrausch's law and its significance – determination of equivalent conductance at infinite dilution for weak electrolyte.

**Transport number:** Definition and explanation, anomalous transport number – explanation with examples – relationship between ionic conductance and transport number (to be derived), determination of transport number by moving boundary method – transport number of  $H^+$  using  $CdCl_2$  as supporting electrolyte (numerical problems on equivalent conductance, transport numbers and Kohlrausch's law).

**[6 Hours]**

Application of conductance measurements – (a) solubility and solubility product of sparingly soluble salt, (b) ionic product of water, (c) degree of ionization of weak electrolyte. Numerical problems for the applications of a, b and c to be worked out.

Conductometric titration: strong acid vs strong base, weak acid vs strong base, strong acid vs weak base, weak acid vs weak base, with suitable examples for each. **[4 Hours]**

## UNIT II

**Electromotive force-I:** Electrolytic and electrochemical cells, electrode reaction of Daniel cell, single electrode potential, sign of electrode potential-convention (reduction potential to be adopted), convention of representing a cell, EMF and standard EMF of a cell, cell reaction, reversible and irreversible cells, Nernst equation (to be derived) and calculation of electrode potential, standard hydrogen gas electrode, reference electrodes-calomel and Ag-AgCl electrode-construction and working, electrochemical series and its significance, equilibrium constant and free energy of cell reaction, spontaneity of a cell reaction, concentration cells.

**EMF of concentration cells:** Definition with explanation – with transference and without transference, concentration cells – with examples. Liquid junction potential and salt bridge. (Numerical problems on Nernst equation and EMF calculations).

**Fuel cells:** Working of  $H_2-O_2$  fuel cell and its importance.

[6 Hours]

## UNIT III

**Electromotive force-II**

**Application of EMF measurements:** (a) Determination of pH of a solution using quinhydrone electrode and glass electrode (using dip type Calomel electrode) – Explanation with principle and procedure. (b) Potentiometric titration – principle, location of end points in - (1) Neutralization reactions [NaOH Vs HCl] (2) Oxidation-reduction reactions [ $K_2Cr_2O_7$  Vs FAS] (3) Precipitation reaction [KCl Vs  $AgNO_3$ ] and (4) Complexometric reactions ( $ZnSO_4$  Vs  $K_3[Fe(CN)_6]$ )

[3 Hours]

## UNIT IV

**Chemical Kinetics:** Introduction – differential and integrated rate equations for second order kinetics, derivation of second order rate equation when  $a=b$  and  $a \neq b$ , unit of rate constant, half-life period, experimental verification of second order reactions – study of kinetics of saponification of an ester, determination of the order of reaction – differential, time for half-change method and isolation method. Experimental methods of chemical kinetics, conductometric – example - saponification of esters. Potentiometric - example – kinetics of bromination of N,N-di-methyl aniline and spectrophotometric – example – colorimetric study of kinetics of oxidation of Indigocarmine by chloramine-T.

**Application of kinetic studies:** Arriving at the mechanism of urea formation from ammonium cyanate.

**[5 Hours]**

## UNIT V

**Phase equilibria:** Gibb's phase rule – definition of the terms with examples, application to one component system (water system), reduced phase rule – statement, reduced systems, two component system – simple eutectic type KI-water system, freezing mixtures, Pb-Ag system (desilverization of argentiferous lead)

**[4 Hours]**

### Chemistry Syllabus for Practical for B.Sc. Course

**Note: Students should be trained to use electronic balances (three digits)**

**SI units to be used.**

**I Semester: Practical – I**

**3 Hours per week**

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1. Calibration of : (i) Pipette (ii) Burette (iii) Volumetric flask
  2. Preparation of 2N solutions of  $H_2SO_4$ , HCL,  $HNO_3$ ,  $CH_3COOH$  and  $NH_3$
  3. Preparation of standard sodium carbonate solution and standardization of hydrochloric acid solution (methyl orange indicator). Estimation of sodium hydroxide present in the solution using phenolphthalein indicator.
  4. Preparation of standard oxalic acid solution and standardization of sodium hydroxide solution. Estimation of sulphuric acid present in the solution
  5. Preparation of standard potassium biphthalate solution and standardization of sodium hydroxide solution. Estimation of oxalic acid present in the solution.
  6. Preparation of standard oxalic acid solution and standardization of potassium permanganate solution. Estimation of ferrous ammonium sulphate present in the solution
  7. Preparation of standard oxalic acid solution and standardization of potassium permanganate solution. Estimation of hydrogen peroxide present in the solution.
  8. Estimation of sulphuric acid and oxalic acid in a mixture using standard sodium hydroxide and standard potassium permanganate solutions.
  9. Determination of the percentage of available chlorine in the given sample of bleaching powder.
  10. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.



11. Preparation of standard zinc sulphate solution and standardization of EDTA. Estimation of total hardness of water.
12. Estimation of ammonium chloride using standard sodium hydroxide and standard hydrochloric acid solutions (back titration).

## II Semester: Practical – II

**3 Hours per week**

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Part 1: Qualitative analysis of mono functional organic compounds through functional group analysis. Determination of physical constant. Preparation of suitable derivative of the following class.

1. Acids
2. Alcohols
3. Aldehydes
4. Amides
5. Amines
6. Halogenated hydrocarbons
7. Hydrocarbons
8. Ketones
9. Nitro compounds
10. Phenols

**Part 2:** Organic preparations: Recrystallisation and determination of melting point and its importance may be mentioned

1. Acetylation : Preparation of acetanilide from aniline
2. Oxidation: Preparation of benzoic acid from benzaldehyde
3. Nitration : Preparation of m-dinitrobenzene from benzene
4. Hydrolysis : preparation of benzoic acid from ethyl benzoate

### III Semester: Practical – III

3 Hours per week

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1. Give reason and problems related to inorganic analysis.
2. Systematic semi-micro qualitative analysis of a mixture of two simple salts (with no interfering radicals). Including ionic reactions.

The constituent ions in the mixture to be restricted to the following.

Anions:  $\text{HCO}_3^-$ ,  $\text{CO}_3^{2-}$ ,  $\text{SO}_3^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{NO}_3^-$ ,  $\text{BO}_3^{3-}$ ,  $\text{SO}_4^{2-}$  and  $\text{PO}_4^{3-}$

Cations:  $\text{Pb}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^+$ ,  $\text{Na}^+$  and  $\text{NH}_4^+$

Note:

1. Mixtures requiring elimination of phosphate and borate should not be given.
2. Combination of anions in 2<sup>nd</sup> group shall be avoided.
3. Salts that yield double decomposition shall be avoided (like  $\text{BaSO}_4$ ).
4. The combination of two cations in the mixture should belong to different groups. However combinations like  $\text{Mg}^{2+}$  and  $\text{NH}_4^+$  and  $\text{Na}^+$  and  $\text{NH}_4^+$  can be given.

### Part 1:

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of the density using specific gravity bottle and surface tension of a liquid using stalagmometer.
3. Determination of molecular mass of a non-volatile solute by Walker-Lumsden method.
4. Determination of rate constant of the decomposition of hydrogen peroxide catalyzed by  $\text{FeCl}_3$ .
5. Determination of transition temperature of the salt hydrates.
6. Determination of rate constant of saponification of ethyl acetate titrimetrically.
7. Determination of percentage composition of sodium chloride solution by determining the miscibility temperature of phenol - water system.
8. Determination of the mass present in the given solution of a strong acid using strong base by thermometric titration method.
9. Determination of molecular weight of a polymer material by viscosity measurements (cellulose acetate/methyl acrylate).
10. Study of kinetics of reaction between  $\text{K}_2\text{S}_2\text{O}_8$  and KI, second order, determination of rate constant.
11. Determination of distribution coefficient of iodine in water and carbon tetra chloride.

## V Semester: Practical – V and VI

6 Hours (2 practical per week of 3 Hours each)

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### Practical - V:

#### Gravimetric Estimations:

1. Gravimetric estimation of barium as barium sulphate.
2. Gravimetric estimation of iron as iron (III) oxide.
3. Gravimetric estimation of copper as copper (I) thiocyanate.
4. Gravimetric estimation of nickel as nickel dimethylglyoximate.
5. Gravimetric estimation of magnesium as magnesium -8-hydroxy oxinate.
6. Gravimetric estimation of sulphate as barium sulphate.
7. Gravimetric estimation of aluminum as aluminum oxide.
8. Gravimetric estimation of zinc as zinc oxide.
9. Gravimetric estimation of calcium as calcium oxide.
10. Paper chromatographic separation of  $\text{Fe}^{3+}$  and  $\text{Ni}^{2+}$  ions.
11. Paper chromatographic separation of  $\text{Na}^+$  and  $\text{K}^+$  ions

### PRACTICAL - VI:

#### Ore and Alloy Estimations:

1. Preparation of standard potassium dichromate solution and estimation of iron in the given sample of hematite by dichromate method.
2. Estimation of percentage of calcium in limestone by oxalate method.
3. Estimation of manganese in the given sample of pyrolusite.
4. Estimation of magnesium in the given sample of dolomite by EDTA method.
5. Estimation of copper in bronze by iodometric method.
6. Estimation of tin in solder using EDTA.

#### Preparation of Inorganic Complexes

1. Preparation of mercurytetrathiocyanatocobaltate(II).
2. Preparation of potassiumtrioxalatoferrate(III).
3. Preparation of ferrous oxalate.
4. Preparation of potassiumbisoxalatodiaquachromate(III).
5. Preparation of chloropentaminecobalt(III)chloride.
6. Preparation of manganese (III)acetylacetonate.

## VI Semester – Practical VII and VIII

6 Hours (2 practical per week of 3 Hours)

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### Practical VII:

1. Determination of equivalent conductance of the given electrolyte (strong and weak) by using Meter Bridge.
2. Determination of solubility of sparingly soluble salt (like  $\text{BaSO}_4$ ) by conductometric method.
3. Determination of  $K_a$  (dissociation constant of a weak acid) by conductometric method.
4. Determination of rate constant of saponification of ethyl acetate by conductivity measurements.
5. Conductometric titration of strong acid and strong base and weak acid and strong base.
6. Determination of percentage composition of a given mixture containing two miscible liquids by Abbe's refractometer.
7. Potentiometric titration of ferrous ammonium sulphate against potassium dichromate.
8. pH titration of strong acid against strong base ( by observing change in pH).
9. Potentiometric titration of mixture of HCl and  $\text{CH}_3\text{COOH}$  using NaOH solution.
10. Colorimetric estimation of  $\text{Fe}^{3+}$  ion using ammonium thiocyanate as complexing agent.
11. Colorimetric estimation of  $\text{Cu}^{2+}$  ion using  $\text{NH}_4\text{OH}$  as complexing agent.
12. Colorimetric study of kinetics of oxidation of indigocarmine by chloramine-T.

### Practical-VIII

#### Organic Estimations:

1. Separation of p- and o-nitroaniline by TLC method (Solvent extraction).
2. Separation of p- and o-nitroaniline by column chromatography.
3. Estimation of glucose by Fehling solution method.
4. Estimation of Phenol by acetylation method.
5. Estimation of ascorbic acid by iodometric method.
6. Determination of Iodine value of oils by chloramine-T.
7. Isolation of Caffeine from tea powder.
8. Isolation of Castor oil from Castor seeds.
9. Estimation of neutral amino acids by titrametric method.
10. Estimation of carboxylic acid by titrametric method.
11. Estimation of  $-\text{NH}_2$  group by acetylation method.
12. Determination of saponification value of oils.

## Recommended Books

### INORGANIC CHEMISTRY

| Sl. No. | Title of the book                         | Author                  | Publisher                       |
|---------|---|-------------------------|---------------------------------|
| 1       | A Text book of Inorganic Chemistry        | P. L. Soni              | Sultan Chand & Sons             |
| 2       | A Text book of Inorganic Chemistry        | B. R. Puri & L. Sharma  | Shobhanlal Nagin Chand Co.      |
| 3       | Principles of Inorganic Chemistry         | Puri, Sharma & Kalia    | Shobhanlal Nagin Chand Co.      |
| 4       | A Text book of Inorganic Chemistry        | Gurudeep Raj            |                                 |
| 5       | Concise Inorganic Chemistry               | J. D. Lee               | B-Block Well Science Ltd.       |
| 6       | A Text book of Inorganic Chemistry        | Sathya Prakash & others |                                 |
| 7       | Basic concepts of Analytical Chemistry    | S. M. Khopkar           | New Age International           |
| 8       | Selected Topics in Inorganic Chemistry    | Madan, Malik, Tuli      | S. Chand & Company              |
| 9       | A Text book of Inorganic Chemistry        | A. K. De                | New Age International           |
| 10      | Comprehensive Inorganic Chemistry         | O. P. Agarwal           |                                 |
| 11      | Inorganic Chemistry                       | Kapoor & Chopra         |                                 |
| 12      | Engineering Chemistry                     | B. K. Sharma            |                                 |
| 13      | Industrial Chemistry                      | B. K. Sharma            |                                 |
| 14      | Engineering Chemistry                     | Jayaprakash & Venugopal |                                 |
| 15      | Engineering Chemistry                     | Jain and Jain           |                                 |
| 16      | Hand book of Industrial Chemistry         | Riegel's James A. Kent  | B. S. Publishers & Distributors |
| 17      | Instrumental methods of Chemical analysis | B. K. Sharma            | Goel Publishing House           |

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|----|---|--|------------------------------------|
| 18 | Elements of Nuclear Chemistry                 | R. Gopalan   | Vikas Publishing House             |
| 19 | Industrial Chemistry                          | B. N. Chakarbathy  | Oxford & IBH Publishers            |
| 20 | Instrumental methods of Chemical analysis     | Gurdeep R. Chatwal & Sham Anand                          | Himalaya Publishing House          |
| 21 | A Textbook Quantitative analysis              | A. I. Vogel  | ELBS                               |
| 22 | A Textbook Quantitative analysis              | A. I. Vogel  | ELBS                               |
| 23 | Management of Water Resources in Agriculture  | V. S. Shriramulu   |                                    |
| 24 | Inorganic Polymers                            | C. R. Chatwal  | Himalaya Publishing House          |
| 25 | Theoretical Principles of Inorganic Chemistry | Manku  | Tata McGraw Hills                  |
| 26 | Advanced Practical Inorganic Chemistry        | Gurudeep Raj   | Goel Publishing House              |
| 27 | Experimental Inorganic/Physical Chemistry     | Mounir A. Malati   | Horward Series in Chemical science |
| 28 | University Chemistry                          | C. N. R. Rao   | Mac Millan Company                 |
| 29 | A Text book of Inorganic Chemistry            | Robinson & Heslop  | New Age Publications               |
| 30 | A Text book of Inorganic Chemistry            | Emeleus & Anderson                                       | New Age Publications               |
| 31 | A Text book of Inorganic Chemistry            | F. A. Cotton & G. Wilkinson                              | Wiley Interscience                 |
| 32 | Analytical Chemistry                          | Willard, Meritind & Dean                                 | New Age Publications               |
| 33 | Advanced Chemistry                            | Philip Mathews   | Cambridge University Press         |
| 34 | Instrumental methods of Chemical analysis     | H. H. Willard, L. L. Merrite, K. A. Dean & F. A. Skettle | CBS Publishers                     |

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| 35 | A Text book of Inorganic Chemistry           | Emelius H. J., Sharpe A. G.       | University Book Stall<br>New Delhi                |
| 36 | Theoretical Inorganic Chemistry              | Dey & Selbin                      | University Book Stall<br>New Delhi                |
| 37 | Analytical Chemistry                         | John.H. Chenady                   | Saunders College,<br>Publishing New York<br>Tokyo |
| 38 | Introduction to nanoscience & nanotechnology | Chattopadhyay                     | PHI   |
| 39 | Nanotechnology fundamentals & applications   | Manasi Karkare                    | IKI NTPC  |
| 40 | Nanotechnology                               | Richard Brooker , Earl boyson     | Wiley Dream Tech India                            |
| 41 | Advances in nanoscience & nanotechnology     | Dr. Shuthosh Sharma & Dr. Bellari | CSIR Publications                                 |

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### ORGANIC CHEMISTRY

| Sl. No. | Title of the book                      | Author        | Publisher                       |
|---------|--|---------------|---------------------------------|
| 1       | A Text book of Organic Chemistry       | M. K. Jain    | S. Chand & Company              |
| 2       | A Text book of Organic Chemistry       | Bhal & Bhal   | S. Chand & Company              |
| 3       | A Text book of Organic Chemistry       | P. L. Soni    | S. Chand & Company              |
| 4       | Laboratory Manual of Organic Chemistry | Raj K. Bansal | New Age Publications            |
| 5       | Laboratory Manual of Organic Chemistry | Jayaraman     | S. Chand & Company              |
| 6       | Chemistry of Natural products          | Aggarwal      | Goel Publishing House<br>Meerut |
| 7       | Organic Chemistry                      | K. K. Sharma  | Shobhanlal & Nagan<br>Company   |



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| 8  | Organic Chemistry  | Puri & Sharma                   | Shobhanlal & Nagan Company        |
| 9  | Medicinal Chemistry                                      | Ashuthosh Kar                   | Tata Mcgraw Hill Publications     |
| 10 | Organic Chemistry  | Handrickson                     | Tata Mcgraw Hill Publications     |
| 11 | Organic Synthesis special techniques                     | V. K. Ahluwalia & Renu Aggarwal | Narosa publishing House           |
| 12 | Organic Chemistry Vol. I & II                            | I. L. Finar                     | ELBS                              |
| 13 | Stereo Chemistry   | Eliel                           | John Wiley Eastern Publications   |
| 14 | Text Book of Qualitative & Quantitative Organic Analysis | Arthur Vogel                    | ELBS                              |
| 15 | Heterocyclic Chemistry                                   | Raj K. Bansal                   | Tata Mcgraw Hill Publications     |
| 16 | Laboratory Manual of Organic Chemistry                   | Skoog & West                    | Prentice-Hall of India Pvt. India |
| 17 | Manual of organic Chemistry                              | Dey & Seetharamanssss           |                                   |
| 18 | A text book of practical organic chemistry               | A. I. Vogel Volume-III          |                                   |
| 19 | Practical Organic chemistry                              | Mann & Saunders                 |                                   |
| 20 | An introduction Green Chemistry                          | V. Kumar                        |                                   |

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## PHYSICAL CHEMISTRY

| Sl. No. | Title of the book                           | Author   | Publisher  |
|---------|---|--|--|
| 1       | Physical Chemistry                          | R. P. Verma                                      | Pradeep Publication                                |
| 2       | Kinetics of Chemical Reactions              | S. K. Jain                                       | Vishal publications,<br>Jalandhar<br><br>New Delhi |
| 3       | Physical Chemistry                          | M. Kundan & S. K. Jain                           | S. Chand & Company                                 |
| 4       | Text book of Physical Chemistry             | K. K. Sharma & C. K. Sharma                      | Vani Educational Books                             |
| 5       | Biophysical Chemistry                       | Upadhyaya & Upadhyaya                            | Himalaya Publishing Homes                          |
| 6       | Principles of physical chemistry            | Puri, Sharma & Pathania                          |  |
| 7       | Essentials of physical chemistry            | B. S. Bahl, Arun Bahl & G. D. Tuli               |  |
| 8       | Polymer Science                             | V. R. Gowriker, N. V. Vishwanathan & J. Sreedhar |  |
| 9       | Quantum Chemistry (2 <sup>nd</sup> edition) | A.K. Chandra                                     |  |
| 10      | Quantum Chemistry                           | R.K. Prasad                                      |  |
| 11      | Colloidal Chemistry                         | D. K. Sharma                                     | Goel Prakashan. Meerut                             |
| 12      | Physical Chemistry                          | R. L. Madan & G. D. Tuli                         | S. Chand & Company                                 |
| 13      | Text book of advanced Physical Chemistry    | Gurudeep Raj                                     | Goel Prakashan. Meerut                             |
| 14      | Principles and Applications of Catalysis    | B. Vishwanath                                    | Narosa Publishing House                            |
| 15      | Engineering Chemistry                       | Jain & Jain                                      | Dhanpal & Sons, New Delhi                          |
| 16      | Text Book of Physical Chemistry             | B. D. Khosla                                     | R. Chand & Publications                            |

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| 17 | Fundamentals of Molecular Spectroscopy | Colin N. Banwell & Elleine M. Meeash | Himalaya Publishing Group                |
| 18 | Physical Chemistry                     | Colin N. Banwell                     | Himalaya Publishing Group                |
| 19 | Physical Chemistry                     | Glasstone                            | ELBS                                     |
| 20 | Text book of Chemical Kinetics         | Laidier                              | New Age Publication                      |
| 21 | Text book of Photochemistry            | W. Bansal                            | S. Chand & Company                       |
| 22 | Text book of Thermodynamics            | Glasstone                            | East-West Press Pvt. Ltd.                |
| 23 | Text book of Electrochemistry          | Glasstone                            | East-West Press Pvt. Ltd.                |
| 24 | Physical Chemistry                     | Rakshit                              |  |
| 25 | Physical Chemistry                     | Pathania & Sharma                    | Vishal Publications<br>Jalandhar & Delhi |