

COURSE CURRICULUM AND SYLLABUS OF THREE YEAR DEGREE COURSE

CHEMISTRY

B. Sc. I year

Paper code	Paper	Nomenclature	Lecture	Hrs/ Week	Durati on of exam	Max. Marks	Min. Marks
CHEM 111	I	Inorganic Chemistry	60 hrs	2	3 hrs	50	18
CHEM 112	II	Organic Chemistry	60 hrs	2	3 hrs	50	18
CHEM 113	III	Physical Chemistry	60 hrs	2	3 hrs	50	18
CHEM 114	IV	Practical Chemistry	120 hrs	4	5 hrs	75	27

Each theory paper in the annual examination shall have three sections.

- **Section A** shall contain one compulsory question of 5 marks having 15 parts. Three parts shall be set from each unit. The candidate is required to answer two parts from each unit in about 20 words.
- **Section B** shall contain five compulsory questions of 5 marks each with internal choice. One question with internal choice will be set from each unit. The answer may be given in approximately 250 words.
- **Section C** shall contain five descriptive questions, one question shall be set from each unit and candidate has to answer any two questions of ten marks each. The answer may be given in approximately 500 words. There can be two parts in a question from this section.

## Scheme of Studies

### B. Sc. I Year (Annual Scheme)

S. No.	PAPER	NOMENCLATURE	COURSE CODE	UNIV. EXAM	INTERNAL ASSESSMENT	MAX. MARKS
1.	Paper I	Inorganic Chemistry	CHEM-111	35	15	50
2.	Paper II	Organic Chemistry	CHEM- 112	35	15	50
3.	Paper III	Physical Chemistry	CHEM- 113	35	15	50
4.	Paper IV	Practical Chemistry	CHEM-114	75	-	75
					<b>TOTAL</b>	<b>225</b>

The marks distribution of internal assessment-

- a) Mid Term Examination – 10 marks
- b) Attendance – 5 marks

## FIRST YEAR T.D.C. SCIENCE CHEMISTRY

### CHEM-111 PAPER I : INORGANIC CHEMISTRY

Time : 3 Hrs.

M.M. 50

#### UNIT I

##### **Atomic structure :**

Idea of de Broglie waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, signification of  $\psi$  and  $\psi^2$ , quantum numbers, radial and angular wave function and probability distribution curve, Shape of S,p,d orbitals, aufbau and Pauli exclusion principles, Hund's multiplicity rule, electronic configuration of elements, effective nuclear charge.

**Covalent Bond:** Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory, regular and deviation from regular geometry, MO theory, homonuclear and heteronuclear (CO, NO, HF and HCl) diatomic molecules, multi center bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

**Ionic Solids :** Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, hydration energy and solubility of ionic solids, polarizing power and polarizing of ions.

Fajan's rule, Metallic bond - free electron, valence bond and band theories.

**Weak Interactions:** Hydrogen bonding, Van der Waals forces.

#### UNIT II

**Periodic Properties:** Atomic and Ionic radii, Ionisation energy, electron affinity - definition, methods of determination or evaluation, trends in periodic table and application in predicting and explaining the chemical behavior

**s-Block Elements :** Comparative study, diagonal relationships, salient features of

hydrides, solvation and complexation tendencies including their function in bio-systems, an introduction to metal alkyls and aryls.

**Chemistry of Noble Gases :** History of discovery, separation of inert gases, chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.

### UNIT III

**Group 13 :** General properties, oxides, hydroxide, halides and hydrides of boron, diborane and higher boranes, borohydrides, borazine, oxyacids of boron, borax and borax bead test.

**Group 14 :** General properties, inert pair effect, halides, oxides, silicates, silicones, graphitic compounds, carbides, cyanides and carbonyls, brief idea of fullerenes.

**Group 15 :** General properties, hydrides, azides, halides, oxides and oxyacids of phosphorous, nitrogen fixation, fertilizers.

### UNIT IV

**Group 16 :** General properties, polymorphism, hydrides, halides, oxides and oxyacids of sulphur, thiosulphuric acid and salts, thionic acids and their salts, tetrasulphur tetranitride.

**Group 17 :** General properties hydrogen halides, oxides and oxyacids of halogens, interhalogen compounds polyhalides, basic properties of halogens.

### UNIT V

**Non-Aqueous Solvents :** Physical properties of a solvent, types of solvents and their general characteristics, Differentiating and leveling solvents, reactions in non-aqueous solvents with special reference to liquid  $\text{NH}_3$  and liquid  $\text{SO}_2$ .

**Acids and Bases :** Arrhenius, Bronsted - Lowry, Lax - Flood, solvent system and Lewis concepts of acid and bases, Usanovitch definition.

### BOOKS RECOMMENDED

1. Concise Inorganic Chemistry : J.D. Lee
2. General Inorganic Chemistry : J.A. Duffy, Longman (2nd Ed.)

3. Principles of Inorganic Chemistry : B.R. Pun and L.R. Sharma.
4. Basic Inorganic Chemistry : F.A. Cotton and G. Wilkinson, Wiley Eastern.
5. Molecular Geometry : R.J. Gillespie, Van Nostrand Reinhold.
6. Inorganic Chemistry (Hindi ed.) : Suresh Ameta, A. Sharma and M. Mehta, Himanshu Publication.

## FIRST YEAR T.D.C. SCIENCE CHEMISTRY

### CHEM-112 PAPER II : ORGANIC CHEMISTRY

Time : 3 Hrs.

M.M. 50

#### UNIT I

**Structure and Bonding** : Localized and delocalized chemical bond, Van der Waals interaction, charge transfer complexes, resonance, hyperconjugation, aromaticity electrometric, inductive and field effects, hydrogen bonding.

**Mechanism of Organic Reactions** : Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, types of organic reactions, energy considerations.

**Types of Bond cleavage** : Homolytic and heterolytic cleavage.

**Reactive Intermediates** : Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes, their formation, stabilities and evidence.

#### UNIT II

**Stereochemistry of Organic Compounds** : Concept of isomerism, types of isomerism.

Difference between configuration and conformation.

Conformational isomerism- conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer and Flying Wedge formulae.

**Optical Isomerism** : Elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.

Relative and absolute configuration. sequence rules. D and L, R and S systems of nomenclature.

Geometric isomerism- determination of configuration of geometric isomers. E and Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.

### UNIT III

**Alkenes, Dienes and Alkynes :** Brief introduction of alkenes, their formation with reference to mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes.

**Chemical Reactions of Alkenes :** mechanisms involved in hydrogenation, electrophilic and free radical additions, hydroboration-oxidation, Markownikof Oxymercuration-reduction, epoxidation, ozonolysis, hydration, hydroxylation and oxidation with  $\text{KMnO}_4$  polymerization of alkenes, substitution at the allylic and vinylic positions of alkenes, industrial applications of ethylene and propene.

**Nomenclature and Classification of Dienes :** Isolated, conjugated and cumulated dienes, structure of allenes and butadiene, methods of formation, polymerization, chemical reactions- 1,2 and 1,4- additions, Diels - Alder reaction.

**Alkynes :** Acidity of alkynes, mechanism of electrophilic and nucleophilic addition reactions, hydroboration, metal-ammonia reductions, oxidation and polymerization.

### UNIT IV

**Arenes and Aromaticity :** Nomenclature of benzene derivatives, the aryl group, aromatic nucleus and side chain, structure of benzene, molecular formula and Kekule structure, stability and carbon - carbon bond lengths of benzene, resonance structure, and M.O. picture.

**Aromaticity :** The Huckel rule, aromatic ions. Aromatic electrophilic substitution: General pattern of the mechanism, role of s and p complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Craft reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho-para ratio. Side chain reactions of benzene derivatives, Birch reduction, Methods of formation and chemical reactions of alkylbenzenes. alkynylbenzene and biphenyl.

**UNIT V**

**Alkyl and Aryl Halides :** Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, mechanism of nucleophilic substitution reactions of alkyl halides,  $S_N^2$  and  $S_N^1$  reactions with energy profile diagrams, factors affecting  $S_N^2$  and  $S_N^1$  reactions.

Haloform reaction, Freons .

Methods of formation of aryl halides, nuclear and side chain reactions, the addition - elimination and elimination - addition reaction, mechanisms of nucleophilic aromatic substitution reactions.

Relative reactivities of alkyl halides v/S allyl, vinyl and aryl halides, synthesis and uses of DDT and BHC.

**BOOKS RECOMMENDED**

1. A Text Book of Organic Chemistry : K.S. Tiwari, S.N. Mehrotra and N.K. Vishnoi.
2. Modern Principles of Organic Chemistry : M.K. Jain and S.C. Sharma
3. A Text Book of Organic Chemistry : (Vol. I and II), O.P. Agarwal.
4. A Text Book of Organic Chemistry : B.S. Bahl and Arun Bahl.
5. A Text Book of Organic Chemistry : P.L. Soni.
6. Organic Chemistry : (Vol. I) S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd., (New Age International).
7. Organic Chemistry, Morrison and Boyd, Prentice Hall.
8. Organic Chemistry (Hindi Ed.) : Suresh Ameta, P.B. Punjabi and B.K. Sharma, Himanshu Pub.
9. Organic chemistry Vol I : Jagdamba Singh: Pragati Prakashan
10. Organic Chemistry Vol I: Wadhwa, Dixit: Ram Prasad Publications.



## FIRST YEAR T.D.C. SCIENCE CHEMISTRY

### CHEM-113 PAPER III : PHYSICAL CHEMISTRY

Time : 3 Hrs.

M.M. 50

#### UNIT I

**Mathematical Concepts** : - Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of function like  $kx$ ,  $e^x$ ,  $x^n$ ,  $\sin x$ ,  $\log x$ , maxima and minima, partial differentiation and reciprocity relations, integration of some useful/relevant functions, permutations and combinations, factorials, probability.

**Computers** : General introduction to computers, different components of a computer, hardware and software, input-output devices, binary numbers and arithmetic, introduction to computer languages, programming operating systems.

#### UNIT II

**Gaseous State** : Postulates of kinetic theory of gases, deviation from ideal behavior, Van- der Waals equation of state.

**Critical Phenomena** : PV isotherms of real gases, continuity of states, the isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state.

**Molecular Velocities** : Root mean square, average and most probable velocities, qualitative discussion of the Maxwell's distri number, mean free path and collision diameter, liquefaction of gases (based on Joule - Thomson effect).

**Liquid State** : Intermolecular forces, structure of liquid (a qualitative description). Structure differences between Solid, liquid and gases

**Liquid Crystals** : Difference between liquid crystal, solid and liquid, classification, structure of smetic, nematic and cholestric phases, theory of liquid crystals and its applications, thermography and seven segments cell.

#### UNIT III

**Solid State :** Definition of space lattice, unit cell, Bravais lattices.

**Laws of crystallography :** (i) Law of constancy of interfacial angles (ii) Law of rationality of indices, Weiss and Miller indices (iii) Law of symmetry, symmetry elements in crystals classification of crystals, X-ray diffraction by crystals derivation of Bragg equation, determination of crystal structure of NaCl, method and powder method).

**Colloidal State :** Definition of colloids, classification of colloids.

Solids in liquid (sols): Properties - kinetic, optical and electrical, stability of colloids, protective action, Hardy - Schulze law, gold number.

Liquids in Liquid (emulsions): Types of emulsions, preparation. emulsifier, Liquids in solid (gels)- classification, preparation and properties inhibition, general applications of colloids.

#### UNIT IV

**Chemical Kinetics and Catalysis:** Chemical Kinetics and its scope , rate of reaction, factor, influencing rate of reaction, Concentration, temperature, pressure, solvent, light, catalysis, concentration dependence of rate, mathematical characterization of simple chemical reaction, zero order, first order, second order, pseudo order, half life, and mean life, determination of order of reaction- differential method, method of integration, method of half life period and isolation method.

Radio active decay as first order phenomenon.

Experimental method of chemical kinetics: effects of temperature on rate of reaction, Arrhenius equation, Concept of activation energy.

Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis), Expression for the rate constant based on equilibrium constant and thermo dynamic aspects.

Catalysis, Characterisation of catalysed reactions, classification of catalysis, miscellaneous examples.

#### UNIT V

**Nuclear and Radiochemistry :** Elementary idea of nucleus, nuclear forces, packing fraction, mass defect and binding energy, nuclear fission and fusion reactions, calculation of Q - values of nuclear reactions, liquid drop and shell models of nucleus, theory of radioactivity, G.M. Counter, half life period, average life,

radioactive disintegration, radioactive steady state, group displacement law, radioactive series, separation and identification of isotopes, application of radioactivity and radioactive tracers.

**Physical Properties and Molecular Structure :** Physical properties of liquids, vapour pressure, measurement of vapour pressure, heat of vaporization, Trouton's rule. Surface tension, measurement of surface tension.

Viscosity and its measurement, effect of temperature on the surface tension and viscosity, use of these properties in determination of chemical constitution.

### **BOOKS RECOMMENDED**

1. Principles of Physical Chemistry: B.R. Puri and L.R. Sharma.
2. A Text Book of Physical Chemistry: A.S. Negi and S.C. Anand.
3. Physical Chemistry, Pt. I & II : C.M. Gupta, J.K. Saxena and M.C. Purohit.
4. Physical Chemistry (Hindi Ed.) : Suresh Ameta, R.C. Khandelwal, R. Ameta and J. Vardia, Himanshu Pub.
5. Computers and Applications to Chemistry, Ramesh Kumari, Narosa Publishing House Pvt. Ltd.

**FIRST YEAR T.D.C. SCIENCE CHEMISTRY**

**CHEM-114  
PAPER- IV : PRACTICAL CHEMISTRY**

Time : 5 Hrs (One day)

M.M. 75

**Distribution of Marks**

<b>Exercises</b>		<b>Marks</b>
1.	Semi-micro analysis of Inorganic mixture containing five radicals (excluding Na <sup>+</sup> and K <sup>+</sup> )	20
2.	(i) Detection of extra element (N, S and halogen) if any and functional groups in given sample organic compounds.	10
	(ii) Purification of the given organic compounds by crystallization (charcoal) sublimation and determination of its m.p. <b>OR</b> Determination of mixed melting points using urea-cinnamic acid mixtures of given compositions.	10
3.	One Physical Chemistry Experiment	15
4.	Vice-voice	10
5.	Record	10
<b>Total</b>		<b>75 marks</b>

**LIST OF EXPERIMENTS**

- Semi-micro Analysis of Inorganic mixture:** The mixture shall contain **Five** radicals at least two cations and two anions) soluble in water or in HCl. Two cations of the same group except IIA and IIB may be given. Not more than one interfering radical may be given. Interfering radical may not be given with typical anion combinations.
- (i) Detection of extra elements (N.S. and halogen) if any and functional group in given simple organic compounds (one organic compound from the following list be given for identification).  
  
Carboxylic acids, Phenols, Alcohols, Carbohydrates, Aldehydes, Ketones, Nitro.  
  
Compounds : Amino compounds, Anilides Amides, Esters, Thiomide,

Hydrocarbons, Halogen containing compounds.

(ii) **Crystallization :**

Concept of induction of crystallization.

Phthalic acid from hot water (using fluted filter paper and stemless funnel)

Acetanilide from boiling water.

Naphthalene from ethanol

Benzoic acid from water

**Decolourization and crystallization using charcol :** Crystallization and decolourization of impure naphthalene (100 g of naphthalene mixed with 0.3 of Congo Red using 1 g decolourizing carbon) from ethanol.

**Simple Sublimation :** Camphor, Naphthalene, Phthalic acid and Succinic acid.

**Mixed Melting Point determination:** Urea - Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1).

**3. Physical Chemistry Experiments :** Any one of the following experiments may be given in the examination.

**Distribution Law**

- (i) To study the distribution of iodine between water and  $\text{CCl}_4$ .
- (ii) To study the distribution of benzoic acid between benzene and water.
- (iii) To study the distribution of acetic acid between benzene and water.

**Colloids :** To prepare arsenious sulphide sol. and compare the precipitating power of mono-, bi- and trivalent anions.

**Viscosity and Surface Tension**

- (i) To determine the percentage composition of a given mixture (non-interacting systems) by viscosity method.
- (ii) To determine the percentage composition of a given binary mixture by surface tension method.
- (iii) To determine the parachor value of  $-\text{CH}_2-$  group.
- (iv) To determine the rheochor value of  $-\text{CH}_2-$  group.

**Transition Temperature**

- (i) Determination of transition temperature of the given substance by thermometric/ dilatometric method (e.g. :  $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$ ,  $\text{SrBr}_2 \cdot 2\text{H}_2\text{O}$ ).

### Thermochemistry

- (i) To determine the solubility of benzoic acid at different temperatures and to determine  $\Delta H$  of the dissolution process.
- (ii) To determine the enthalpy of neutralisation of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
- (iii) To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle.

### BOOKS RECOMMENDED

1. Practical Chemistry - Giri, Bajpai and Pandey, S. Chand & Co. Ltd., New Delhi.
2. Laboratory Manual in Organic Chemistry, R.K. Bansal, Willey Eastern.
3. Experimental Organic Chemistry, Vol. I and II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
4. Experiments in Physical Chemistry - J.C. Ghose, Bharti Bhawan.
5. Experiments in General Chemistry, N.r. Rado and U.C. Agarwal, Eastern Press.
6. Practical Chemistry - Suresh Ameta and P.b. Punjabi, Himanshu Publication.

COURSE CURRICULUM AND SYLLABUS OF THREE YEAR DEGREE COURSE

CHEMISTRY

B. Sc. II year

Paper code	Paper	Nomenclature	Lecture	Hrs/ Week	Durati on of exam	Max. Marks	Min. Marks
CHEM 221	I	Inorganic Chemistry	60 hrs	2	3 hrs	50	18
CHEM 222	II	Organic Chemistry	60 hrs	2	3 hrs	50	18
CHEM 223	III	Physical Chemistry	60 hrs	2	3 hrs	50	18
CHEM 224	IV	Practical Chemistry	120 hrs	4	5 hrs	75	27

Each theory paper in the annual examination shall have three sections.

- **Section A** shall contain one compulsory question of 5 marks having 15 parts. Three parts shall be set from each unit. The candidate is required to answer two parts from each unit in about 20 words.
- **Section B** shall contain five compulsory questions of 5 marks each with internal choice. One question with internal choice will be set from each unit. The answer may be given in approximately 250 words.
- **Section C** shall contain five descriptive questions, one question shall be set from each unit and candidate has to answer any two questions of ten marks each. The answer may be given in approximately 500 words. There can be two parts in a question from this section.

## Scheme of Studies

### B.Sc. II Year (Annual Scheme)

S. No.	PAPER	NOMENCLATURE	COURSE CODE	UNIV. EXAM	INTERNAL ASSESSMENT	MAX. MARKS
1.	Paper I	Inorganic Chemistry	CHEM-221	35	15	50
2.	Paper II	Organic Chemistry	CHEM-222	35	15	50
3.	Paper III	Physical Chemistry	CHEM-223	35	15	50
4.	Paper IV	Practical Chemistry	CHEM-224	75	-	75
					<b>TOTAL</b>	<b>225</b>

The marks distribution of internal assessment-

1. Mid Term Examination – 10 marks
2. Attendance – 5 marks



## SECOND YEAR T.D.C. SCIENCE CHEMISTRY

### CHEM-221 PAPER I : INORGANIC CHEMISTRY

Time : 3 Hrs.

M.M. 50

#### UNIT I

**Chemistry of Elements of First Transition Series :** Characteristic properties of d-block elements (colour variable valency, magnetic and catalytic properties and ability to form complexes). Properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry.

**Chemistry of Elements of Second and Third Transition Series :** General characteristics, comparative treatment with their 3d-analogues in respect of ionic radii oxidation states, magnetic behaviour, spectral properties and stereochemistry.

#### UNIT II

**Oxidation and Reduction :** Use of redox potential data analysis of redox cycle, redox stability in water- Frost, Latimer and Pourbaix diagrams, principles involved in the extraction of the elements.

**Coordination Compounds :** Werner's coordination theory and its experimental verification, effective atomic number concept, nomenclature of coordination compounds, isomerism in coordination compounds valence bond theory of transition metal complexes, chelate and chelate effects.

#### UNIT III

**Chemistry of Lanthanides :** Electronic structure, oxidation states and ionic radii, lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds.

**Chemistry of Actinides** : General feature and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between the later actinides and the later lanthanides.

#### UNIT IV

**Gravimetric Analysis** : Principles, solubility, formation and preparation of precipitation, colloidal properties, ageing and contamination of the precipitates, co-precipitation and post-precipitation.

**Simple Organic Reagents used in Inorganic Analysis** : 8-Hydroxyquinoline, Dimethylglyoxime,  $\alpha$ -nitroso- $\beta$ -naphthol, Anthranilic acid, Arsenic acid, Cupron and Cupferron.

#### UNIT V

**Chromatography** : Basic principles, instrumentation and application of adsorption and partition chromatography, ion exchange separation.

**Errors in Quantitative Analysis** : Accuracy and precision, determinate, indeterminate and accidental errors, precision of a single measurement, precision of mean rejection of result, errors in a derived result methods of checking the accuracy of analysis, significant figures, computation values.

#### BOOKS RECOMMENDED

7. Text Book of Quantitative Inorganic Analysis : A.I. Vogel (Chapter I, II and XXIII).
8. Text Book of Quantitative Inorganic Analysis : I.M. Kolthoff and E.R. Sandell.
9. Concise Inorganic Chemistry : J.D. Lee.
10. General Inorganic Chemistry : J.A. Duffy.
11. Principle of Inorganic Chemistry : B.R. Puri and L.R. Sharma.
12. Basic Inorganic Chemistry : Cotton and Wilkinson and Gaus. Willey.
13. Inorganic Chemistry (Hindi ed.) : Suresh Ameta, A. Sharma and M. Metha, Himanshu Pub.

## SECOND YEAR T.D.C. SCIENCE CHEMISTRY

### CHEM-222 PAPER II : ORGANIC CHEMISTRY

Time : 3 Hrs.

M.M. 50

#### UNIT I

##### **Alcohols and Epoxides :**

Unsaturated alcohols - Vinyl and Allyl alcohol.

Dihydric alcohol - Nomenclature, method of formation and chemical reactions of vicinal glycols.

Pinacol - Pinacolone rearrangement.

Trihydric alcohols - Formation and chemical reactions of glycerol.

Epoxides - Synthesis and reactions of epoxides, orientation of epoxide ring opening.

**Phenols** - Nomenclature, structure and bonding preparation of phenols, physical properties and acidic character, comparative acidic strength of alcohols and phenols, resonance stabilization of phenoxide ion.

Reactions of phenols - Electrophilic aromatic substitution, acylation and carboxylation, Mechanism of Fries rearrangement, Claisen rearrangement, Gatterman synthesis. Hauben-Hoesch reaction, Ledgerer Manasse reaction and Reimer-Tiemann reaction.

#### UNIT II

**Aldehydes and Ketones :** Synthesis, chemical and physical properties of aromatic aldehydes and ketones, mechanism of nucleophilic addition to carbonyl group with particular emphasis on Benzoin, Aldol, Perkin and Knoevenagel condensations, condensation with ammonia and its derivatives, Wittig reaction, Mannich reaction.

Use of acetals as protecting group, Oxidation of aldehydes, Baeyer, Villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemmenson, Wolff-Kishner,  $\text{LiAlH}_4$  and  $\text{NaBH}_4$  reductions, Halogenation of enolizable ketones.

#### UNIT III

**Carboxylic Acids and their derivatives :** Nomenclature, structure and bonding, acidity of carboxylic acids, effects of substituents on acid strength, mechanism of decarboxylation, Methods of formation, physical properties and chemical reactions of dicarboxylic acids, oxalic, succinic and phthalic acid Substituted Acids - Methods of formation and chemical reactions of halo acids, hydroxy

acids, malic, tartaric, citric and salicylic acids.

Unsaturated Acids - Acrylic and cinnamic acids.

Introduction to acids derivatives - Preparation, properties and uses of acid halides, amides, anhydrides and esters. Interconversion of acid derivatives by nucleophilic acyl substitution. Mechanism of HVZ reaction, Hofmann - bromamide reaction and ester hydrolysis.

#### UNIT IV

**Organic Compounds of Nitrogen :** Preparation and chemical reactions of nitroarenes. Reactivity of nitro substituted arenes.

Aromatic amines, classification, preparation, properties and uses of primary amino compounds aniline, acetanilide, nitroanilines.

Secondary amino compounds - diphenylamine and N-methylaniline. Tertiary amino compounds - Triphenylamine and N,N-dimethylaniline. Aryl alkyl amine - Benzylamine.

Basic strength of amines - similarities and differences between aliphatic and aromatic amines.

Diazonium salt - formation, properties and synthetic uses of benzene diazonium salt, Diazo coupling and its mechanism.

**Organic Sulphur Compounds :** Preparation and properties of thiols, sulphonic acid, sulphonyl chloride, saccharides, chloramine -T. dichloramine-T and sulphonamides.

#### UNIT V

**Polynuclear Hydrocarbons :** Nomenclature of naphthalene and anthracene derivatives, preparation and properties of naphthalene, anthracene, naphthol, naphthylamine, naphthaquinone and anthraquinone.

Mechanism and orientation of electrophilic substitution reaction in naphthalene and anthracene.

**Organic Compounds :** Preparation, properties and synthetic uses of organo lithium and organo zinc compounds.

#### BOOKS RECOMMENDED

1. A Text Book of Organic Chemistry : K.S. Tiwari, S.N. Mehrotra and N.K. Vishnoi.
2. Modern Principles of Organic Chemistry : M.K. Jain and S.C. Sharma
3. A Text Book of Organic Chemistry : (Vol. I and II), O.P. Agarwal.
4. A Text Book of Organic Chemistry : B.S. Bahl and Arun Bahl.
5. A Text Book of Organic Chemistry : P.L. Soni.
6. Organic Chemistry : (Vol. I, II and III), S.M. Mukherji, S.P. Singh and R.P. Kapoor
7. Organic Chemistry (Hindi Ed.) : Suresh Ameta, P.B. Punjabi and B.K. Sharma, Himanshu Pub.

## SECOND YEAR T.D.C. SCIENCE CHEMISTRY

### CHEM-223 PAPER III : PHYSICAL CHEMISTRY

Time : 3 Hrs.

M.M. 50

#### UNIT I

**Thermodynamics-I** : Definition of thermodynamic terms system, surrounding, etc. types of systems, intensive and extensive properties, state and path functions, their differentials, thermodynamics process, concept of heat and work.

First law of Thermodynamics - Statement, definition of internal energy and enthalpy, heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law, Joule-Thomson coefficient and inversion temperature, calculation of  $w$ ,  $q$ ,  $dU$  and  $dH$  for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

Thermo chemistry: Standard state, standard enthalpy of formation. Hess's law of heat summation and its applications, Heat of reaction at constant pressure and at constant volume, Enthalpy of neutralization, bond dissociation energy and its calculation from thermo chemical data, temperature dependence of enthalpy, Kirchhoff's equation.

#### UNIT II

**Thermodynamics - II** : Second law of thermodynamics : need for the law, different statements of the law, Carnot cycle and its efficiency, Carnot theory, thermodynamic scale of temperature.

Concept of entropy : Entropy as a state function, Entropy as a function of  $V$  and  $T$ , entropy as a function of  $P$  and  $T$ . Entropy change in physical change. Clausius inequality, entropy as a criteria of spontaneity and equilibrium, entropy change in ideal gases and mixing of gases.

**Third Law of Thermodynamics** : Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz function, Gibbs function ( $G$ ) and Helmholtz function ( $A$ ) as thermodynamic quantities.  $A$  &  $G$  as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, variation of  $G$  and  $A$  with  $P$  and  $T$ .

**Chemical Equilibrium** : Equilibrium constant and free energy, thermodynamic derivation of law of mass action, distribution principle, Nernst's distribution law for solute, solution and washing of precipitates.

Reaction isotherm and reaction isochore - Clapeyron equation and Clausius - Clapeyron equation, applications, partial molar quantities, partial molar volume and

its distribution, chemical potential and its physical significance, Gibbs-Duhem equation.

### UNIT III

**Macromolecules** : Nomenclature, classification, properties of polymer, mass of macro-molecules, number average and weight average molecular mass, determination of molecular weight by osmotic pressure. viscosity and light scattering and sedimentation (ultra centrifuge) methods.

**Surface Chemistry** : Sorption at surfaces, physical and chemical adsorption, Freundlich, Langmuir and Gibbs adsorption isotherms and their derivation, Streaming potential electrophoresis and electroosmosis.

### UNIT IV

**Phase Equilibrium** : Statement and meaning of the terms - phase, component and degree of freedom, derivation of Gibb's phase r system- water CO<sub>2</sub> and S - system.

Phase equilibria of two component system - Solid - liquid equilibria, simple eutectic, Bi-Cd, Pb-Ag systems, desilverization of lead.

Solid solutions - Compound formation with congruent melting point (Mg - Zn) and incongruent melting point, (NaCl - H<sub>2</sub>O), (FeCl<sub>3</sub> - H<sub>2</sub>O) and (CuSO<sub>4</sub> - H<sub>2</sub>O) systems, freezing mixtures, acetone - dry ice.

Liquid - liquid mixtures: Ideal liquid mixtures, Raoult's-ideal and system, azeotropes: HCl - H<sub>2</sub>O and ethanol - water systems.

Partially miscible liquids: phenol - water, trimethylamine - water, nicotine - water systems, lower and upper consolute temperature, effect of impurity on consolute temperature.

Immiscible liquids, steam distillation.

### UNIT V

**Electrochemistry** : Types of reverse electrode : gas - metal ion, metal-metal ion, metal-insoluble salt - anion and redox electrodes, electrode reactions, Nernst - equation, derivation of cell E.M.F. and single electrode potential standard hydrogen electrode-reference electrodes - standard electrode potential sign conventions, electrochemical series and its significance electrolytic and Galvanic cells- reversible and

irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurements, computation of cell EMF. Calculation of thermodynamic quantities of cell reactions ( $\Delta G$ ,  $\Delta H$  and  $K$ ) polarization over potential and hydrogen over voltage. Concentration cell with or without transport, liquid junction potential application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations.

**Ionic Equilibria** - Arrhenius theory of electrolyte and dilution law, its uses and limitations. Debye - Huckle theory of strong electrolytes, asymmetric electrophoretic. Debye- Falkenhagen and Wein effects, Activity coefficient, mean activity coefficient, ionic strength, Debye- Huckel limiting law.

### **BOOKS RECOMMENDED**

1. Principles of Physical Chemistry : B.R. Puri and L.R. Sharma.
2. A Text Book of Physical Chemistry : A.S. Negi and S.C. Anand.
3. A Text Book of Physical Chemistry : Kundu and Jain.
4. Physical Chemistry (Hindi Ed.) : Suresh Ameta, R.C. Khandelwal, R. Ameta and J. Vardia, Himanshu Pub.

## SECOND YEAR T.D.C. SCIENCE CHEMISTRY

### CHEM-224 PAPER –IV : PRACTICAL CHEMISTRY

Time : 5 Hrs (One day)

M.M. 75

#### Distribution of Marks

	Exercises	Marks
1.	Volumetric Estimation OR Gravimetric Analysis	20
2.	Determination of $R_f$ values and identification of given organic compounds using thin layer/paper chromatography	10
3.	Identification of given organic compounds through functional group analysis	10
4.	Physical Chemistry Experiments	15
5.	Vice-voce	10
6.	Records	10
	<b>Total</b>	<b>75 marks</b>

#### LIST OF EXPERIMENTS

1. **Volumetric Analysis** : Any one of the following exercise may be given in the examination :

Determination of acetic acid in commercial vinegar using NaOH

Determination of alkali content- antacid tablet using HCl.

Estimation of calcium content in chalk as calcium oxalate using permanganate.

Estimation of hardness of water by EDTA.

Estimation of ferrous and ferric ions by dichromate methods.

Estimation of copper using thiosulphate.

Estimation of  $Mg^{2+}$ ,  $Ca^{2+}$  or  $Zn^{2+}$  complexometrically.

OR

#### Gravimetric Analysis :

Analysis of Cu as CuSCN and Ni as Ni (dimethylglyoxime)

*Note: Candidates are required to prepare standard solutions by proper weighing.*

2. **Thin Layer Chromatography** :

Determination of  $R_f$  values and identification of organic compounds.

(a) Separation of green leaf pigments (spinach leaves may be used)



- (b) Preparation and separation of 2,4 dinitrophenylhydrazones of acetone, 2-butanone, hexane-2-one and 3-one using toluene and light petroleum (40: 60)
- (c) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)

**Paper Chromatography:** Determination of R<sub>f</sub> values and identification of organic compounds in a mixture of amino acids / monosaccharides.

### 3. Identification of Organic Compounds:

An organic compound from the following list be given for systematic identification:

- (i) Formic, Acetic, Propanoic and Butanoic acids.
- (ii) Phenols- Phenol, Resorcinol, Hydroquinone, p-Cresol,  $\alpha$ -Naphthol,  $\beta$ -Naphthol.
- (iii) Alcohols- Methyl, Ethyl, Propyl, Isopropyl, n-butyl, isobutyl & tert. butyl alcohol.
- (iv) Carboxylic acids- Oxalic, Tartaric, Citric, Succinic, Benzoic, Cinnamic, Salicylic, Phthalic acids.
- (v) Carbohydrates- Glucose, Fructose, Cane sugar and Starch.
- (vi) Aldehydes- Formaldehyde, Acetaldehyde and Benzaldehyde.
- (vii) Ketones- Acetone, Methyl ethyl ketone, Acetophenone and Benzophenone.
- (viii) Nitro compounds - Nitrobenzene, p-Nitrotoluene and m-Dinitrobenzene.
- (ix) Amino compounds - Aniline, o-, m- and p-toluidine,  $\alpha$ -Naphthylamine and  $\beta$ -Naphthylamine.
- (x) Anilides - Acetanilide and Benzanilide.
- (xi) Amides - Acetamide, Benzamide and Urea.
- (xii) Esters - methyl acetate, Ethyl acetate.
- (xiii) Thioamide - Thiourea.
- (xiv) Hydrocarbons - Benzene, Toluene, Naphthalene and Anthracene.
- (xv) Halogen containing compounds - Chloroform, Chloral hydrate, Iodoform, Chlorobenzene, p-Dichlorobenzene and p-Dibromobenzene.

**4. Physical Chemistry Experiments :** Any one of the following experiments may be given in the examination.

#### Chemical Kinetics

- (i) To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
- (ii) To study the effect of acid strength on the hydrolysis of an ester.
- (iii) To study kinetically the reaction rate of decomposition of iodide by peroxydisulphate.

- (iv) To study the hydrolysis of an ester in presence of a base.
- (v) To determine the relative strength of two acids using ester hydrolysis.

### **Phase Equilibrium**

- (i) To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. Phenol water system) and to determine the concentration of that solute in the given phenol-water system.
- (ii) To construct the phase diagram of two components (e.g. diphenylamine-benzophenone) system by cooling curve method.

### **Adsorption :**

- (i) To study the adsorption of acetic acid by activated charcoal and test the validity of Freundlich or Langmuir adsorption isotherm.
- (ii) To study the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich or Langmuir adsorption isotherm.

### **BOOKS RECOMMENDED**

1. Practical Chemistry - Giri, Bajpai and Pandey, S. Chand & Co. Ltd., New Delhi.
2. Laboratory Manual in Organic Chemistry, R.K. Bansal, Willey Eastern.
3. Experimental Organic Chemistry, Vol. I and II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
4. Experiments in Physical Chemistry - J.C. Ghose, Bharti Bhawan.
5. Experiments in General Chemistry, N.r. Rado and U.C. Agarwal, Eastern Press.
6. Practical Chemistry - Suresh Ameta and P.b. Punjabi, Himanshu Publication.

COURSE CURRICULUM AND SYLLABUS OF THREE YEAR DEGREE COURSE

CHEMISTRY

**B. Sc. III year**

Paper code	Paper	Nomenclature	Lecture	Hrs/ Week	Durati on of exam	Max. Marks	Min. Marks
CHEM 331	I	Inorganic Chemistry	60 hrs	2	3 hrs	50	18
CHEM 332	II	Organic Chemistry	60 hrs	2	3 hrs	50	18
CHEM 333	III	Physical Chemistry	60 hrs	2	3 hrs	50	18
CHEM 334	IV	Practical Chemistry	120 hrs	4	5 hrs	75	27

**Each theory paper in the annual examination shall have three sections.**

- **Section A** shall contain one compulsory question of 5 marks having 15 parts. Three parts shall be set from each unit. The candidate is required to answer two parts from each unit in about 20 words.
- **Section B** shall contain five compulsory questions of 5 marks each with internal choice. One question with internal choice will be set from each unit. The answer may be given in approximately 250 words.
- **Section C** shall contain five descriptive questions, one question shall be set from each unit and candidate has to answer any two questions of ten marks each. The answer may be given in approximately 500 words. There can be two parts in a question from this section.

## Scheme of Studies

### B.Sc. III Year (Annual Scheme)

S. No.	PAPER	NOMENCLATURE	COURSE CODE	UNIV. EXAM	INTERNAL ASSESSMENT	MAX. MARKS
1.	Paper I	Inorganic Chemistry	CHEM-331	35	15	50
2.	Paper II	Organic Chemistry	CHEM- 332	35	15	50
3.	Paper III	Physical Chemistry	CHEM- 333	35	15	50
4.	Paper IV	Chemistry Practical	CHEM-334	75	-	75
					<b>TOTAL</b>	<b>225</b>

**The marks distribution of internal assessment-**

- 1. Mid Term Examination – 10 marks**  
**Attendance – 5 marks**

## THIRD YEAR T.D.C. SCIENCE CHEMISTRY

CHEM-331

### PAPER I : INORGANIC CHEMISTRY

Time : 3 Hrs.

M.M. 50

#### UNIT I

**Hard and Soft Acids and Bases (HSAB)** : Classification of acids and bases as hard and soft. Pearson's-base HSAB strength and concept, hardness and softness acid. Symbiosis, theoretical basis of hardness and softness, electro-negativity and hardness and softness.

**Metal-Ligand Bonding in Transition Metal Complexes** : Limitation of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters, John- Teller effect.

#### UNIT II

**Magnetic Properties of Transition Metal Complex** : Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula. L-S coupling, correlation of  $m$  and  $m_{eff}$  values, orbital contribution to magnetic moments, application of magnetic moment data for 3d- metal complexes.

**Electronic Spectra of Transition Metal Complexes** : Types of electronic transitions, selection rule for d-d transitions, spectroscopic ground states, spectro-chemical series. Orgel-energy level diagram<sup>9</sup>states, discussion for of the d'electronic and spectrum of  $[Ti(H_2O)_3]^3$  complex ion.

#### UNIT III

**Bioinorganic Chemistry** : Essential and trace elements in biological processes, metallo-porphyrins with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to  $Ca^{2+}$ .

**Electro analytical Methods** : EMF measurements, pH,- determination using hydrogen, glass, quinhydrone, antimony and calomel electrodes, potentiometric titrations.

**Volumetric Estimation** : Theory of oxidation - reduction titrations. Theory of complexometric titrations.

#### UNIT IV

**Organometallic Chemistry** - Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyl and aryl of Li, Al, Hg, Sn and Ti, a brief account of metal - ethylenic complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls.

**Thermodynamic and Kinetic Aspects of Metal Complexes** - A brief outline of thermodynamic stability of metal complexes and factors affecting the, stability, Substitution reactions of square planar complexes.

#### UNIT V

**Molecular Symmetry and Group Theory** : Symmetry elements, molecular point groups, group theory and basic properties, similarity transformation and classes, orthogonality theorem, multiplication tables and characters tables of  $C_{2v}$  and  $C_{2v}$  groups.

**Mathematical Techniques** : Least square treatment applied to linear equation  $y = my + c$ , correlation coefficient,  $S_m$  and  $S_c$ .

#### BOOKS RECOMMENDED

14. Group theory and its chemical applications : P.K. Bhattacharya.
15. Inorganic chemistry : J.E. Huysse, Principles of Structure and Reactivity, 3rd Ed.
16. Selected topics in inorganic chemistry : W.U. Malik, G.D. Tuli and R. Madan.
17. Principles of Inorganic Chemistry : D. Banerjee.
18. Modern Aspect of Inorganic Chemistry : H.J. Emeleus and A.G. Sharpe.
19. Inorganic Chemistry (Hindi ed.) : Ameta, Sharma and Metha.

## THIRD YEAR T.D.C. SCIENCE CHEMISTRY

### CHEM-332 PAPER II : ORGANIC CHEMISTRY

Time : 3 Hrs.

M.M. 50

#### UNIT I

**Electromagnetic Spectrum : Absorption Spectra** : Ultraviolet (UV) absorption spectroscopy- absorption laws (Beer-Lambert Law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transition, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones.

Infrared (IR) absorption spectroscopy- molecular vibrations, Hooke's intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

**Nuclear Magnetic Resonance (NMR) spectroscopy** : Proton Magnetic Resonance (PMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1, 1,2 - tribromoethane, ethyl acetate, toluene and acetophenone.

Problem pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.

#### UNIT II

**Heterocyclic compounds** : Introduction, molecular orbital picture and aromatic characteristics of pyrrole, furane, thiophene and pyridine, method of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives, comparison of basicity of pyridine, piperidine and pyrrole.

Introduction to condensed five and six membered heterocycles, preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer Indole synthesis, Skraup's synthesis, Napieralski synthesis and Mechanism Bischler of electrophilic substitution reactions of indole, quinoline and isoquinoline.

### UNIT III

**Organic synthesis via Enolates** - Acidity of alpha hydrogen, alkylation of diethylmalonate and ethylacetoacetate, synthesis of ethyl acetoacetate, Claisen condensation. Keto - Enol tautomerism of ethyl acetoacetate, alkylation of 1,3-dithianes, alkylation and acylation of enamines.

**Carbohydrates** - Classification and nomenclature, monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses, configuration of glucose and fructose, erythro and threo diastereomers. Conversion of glucose into mannose, formation of glycosides, ether and esters. Determination of ring size of glucose and fructose, Cyclic structure of D (+) - glucose. Mechanism of mutarotation.

An introduction to disaccharide (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

### UNIT IV

**Amino Acids, Peptides, Proteins and Nucleic Acids** - Classification, structure and stereochemistry of amino acids, acid-base behavior, isoelectric point and electrophoresis. Preparation and reactions of  $\alpha$ -amino acids.

Structure and nomenclature of peptides and proteins, classification of proteins, peptide structure determination, and group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptide and proteins. Levels of protein structure. Protein denaturation! renaturation.

Nucleic acids: Introduction, constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.

**Fats, Oils and Detergents** - Natural Fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils, saponification value, iodine value, acid value, soaps synthetic detergents, alkyl and aryl sulphonates.

**Photochemistry:** Principles: electronic excitation, excited states, modes of dissipation of energy, energy transfer and quantum efficiency, photoreduction and photochemistry of butadienes

### UNIT V

**Synthetic Polymers** - Addition or chain-growth polymerization, free radical vinyl polymerization, ionic - vinyl polymerizations Ziegler-Natta polymerization and vinyl



polymers. Condensation or step-growth polymerization, polyesters, polyamides, phenol formaldehyde resins, urea-formaldehyde resins, epoxy resins and polyurethanes. natural and synthetic rubbers.

**Synthetic Dyes** - Colour and constitution (electronic concept), classification of dyes. Chemistry and synthesis of methyl orange, Congo red, Malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.

### **BOOKS RECOMMENDED**

1. Organic Chemistry, Vol. I and II, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd.
2. A Text Book of Organic Chemistry, Vol. I and II, K.S. Tewari, S.N. Mehrortra and N.K. Vishnoi.
3. Organic Chemistry, M.K. Jain and S. Sharma.
4. A Text Book of Organic Chemistry, Vol. I and II, O.P. Agarwal.
2. A Text Book of Organic Chemistry, Raj. K. Bansal.
3. Organic Chemistry, Vol. I and II, I.L. Finar.
4. Organic Reaction and their Mechanisms, P.S. Kalsi.
5. Introduction of Petrochemicals, Sukumar Maiti.
6. Organic Chemistry (Hindi Ed.) Suresh Ameta, Punjabi and Sharma.
7. Organic Chemistry, Morrison and Boyd, Prentice Hall.
8. Fundamentals of Organic Chemistry, Solomons, John Wiley.
9. Organic Chemistry, P.L. Soni.
10. A Text Book of Organic Chemistry, V.K. Ahluwalia and Maduri Goyal, Narosa Publishing House Pvt. Ltd.

## THIRD YEAR T.D.C. SCIENCE CHEMISTRY

### CHEM-333 PAPER III : PHYSICAL CHEMISTRY

Time : 3 Hrs.

M.M. 50

#### UNIT I

**Elementary Quantum Mechanics** : Black-body radiation, Planck's radiation law, photo-electric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect. Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in one-dimensional box.

Schrodinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance hydrogen like wave functions, radial wave functions, angular wave function.

Molecular orbital theory, basic ideas- criteria for forming M. O. from A. O., construction of M. O's- H<sub>2</sub> byion, calculation LCAO of energy levels from wave functions, physical picture of bonding and antibonding wave function their characteristics. Hybrid orbitals- sp, sp<sup>2</sup>, sp<sup>3</sup>, calculation of coefficient in these hybrid orbitals.

Introduction to valence bond model of H<sub>2</sub>, M.O. and V. B. models.

#### UNIT II

**Spectroscopy** - Introduction: electromagnetic radiation, regions of the spectrum basic features of different spectrometers statement of the Born- Oppenheimer approximation degrees of freedom.

Rotational Spectrum - Diatomic molecules. energy levels of a rigid rotator (semi-classical principles) selection rules, spectral intensity, distribution using population distribution (Maxwell - Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect.

**Vibrational Spectrum** - Infrared spectrum, energy level of simple harmonic oscillator, selection rules, pure vibrational spectrums intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion

and isotope on the spectrum, idea of vibrational frequencies of different functional groups.

Raman spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

**Electronic Spectrum** - Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck Condon principle.

Qualitative description of s, p and n M.O., their energy levels and the respective transitions.

### UNIT III

**Photochemistry** - Interaction of radiation with matter, difference between thermal and photochemical processes, laws of photochemistry, Grotthus - Drapper law, Stark - Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence non-radiative process (internal conversion, intersystem crossing), high and low quantum yields, photosensitization photochemical equilibrium, photoionization photodimerisation of anthracene, photoinhibition. chemical actinometry.

**Solutions, Dilute Solutions and Colligative Properties** : Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution: colligative properties. Raoult's law, lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement.

Determination of molecular weight from osmotic pressure, elevation of boiling point and depression of freezing point, thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point, experimental methods for determining various colligative properties, abnormal molar mass, degree of dissociation and association of solute, Vant-Hoff factor.

### UNIT IV

**Ionic Conductance** - Electrical transport, conduction in metal and electrolytes, solutions, specific conductance, equivalent conductance and molecular conductance, effect of dilution on conductance, migration and its applications of ions, K transport numbers and its determination by Hittorfs method and moving boundary methods, ionic mobility, application of conductivity measurement, conductometric titrations.

**UNIT V**

**Chemical Kinetics** and Catalysis - Rate of reaction, factors influencing the rate of reaction, concentration, temperature, pressure, solvent, light and catalysis, order of a reaction, zero-order, first order and second order reaction, half life and mean life, conductometric, potentiometric, polarimetric and spectrophotometric methods of determination of order of reactions, method of integration, half life method and isolation method, experimental methods of kinetics, elementary idea about opposing, parallel, consecutive and chain reaction, effect of temperature on reaction rates. Arrhenius equation, concept of activation energy and its (hard sphere model), transition state theory (e

Theory of unimolecular reactions, catalysis, theory and mechanism, classification of catalysis, enzyme catalysis and its mechanism.

**BOOKS RECOMMENDED**

1. Principles of Physical Chemistry : B.R. Puri and L.R. Sharma.
2. A Text Book of Physical Chemistry : A.S. Negi and S.C. Anand.
3. A Text Book of Physical Chemistry : Kundu and Jain.
4. Physical Chemistry (Hindi Ed.) : Suresh Ameta, R.C. Khandelwal, R. Ameta and J. Vardia, Himanshu Pub.

**THIRD YEAR T.D.C. SCIENCE CHEMISTRY****CHEM-334  
PAPER IV : PRACTICAL CHEMISTRY**

Time : 5 Hrs (One day)

M.M. 75

**Distribution of Marks**

<b>Exercises</b>		<b>Marks</b>
1.	Synthesis of Inorganic complex and organic compound	15
2.	Analysis by Colorimetry/Solvent extraction/Ion exchange method	10
3.	Qualitative analysis : Organic mixture analysis	10
4.	One Physical experiment	15
5.	Vice-voce	10
6.	Records	10
<b>Total</b>		<b>75 marks</b>

**LIST OF EXPERIMENTS****5. Synthesis of Inorganic complexes and organic compounds**

Any one of the following preparation may be asked in the examination keeping in view that not more than five students are given the same preparation in a batch of 20 students and nature of preparation should be equally distributed both from the organic and inorganic list.

**Inorganic Complexes**

- Preparation of sodium trisoxalato ferrate (III)
- Preparation of Ni-DMG complex.
- Preparation of cis-and trans-bisoxalato diaquo chromate (III) ion.
- Cuprous chloride
- Sodium thiosulphate
- Ferrous sulphate from Kipp's waste
- Mercury tetrathiocyanate

**Organic Synthesis**

3. Acetylation of salicylic acid, aniline, glucose and hydroquinone, benzoylation of aniline and phenol.
4. Aliphatic electrophilic substitution : Preparation of iodoform from ethanol and acetone.

5. Aromatic electrophilic substitution - Nitration -
- (I) Preparation of m-dinitrobenzene from nitrobenzene.
  - (II) Preparation of p-nitroacetanilide from acetanilide.
- Halogenation -
- (I) Preparation of p-bromoacetanilide from acetanilide.
  - (II) Preparation of 2,4,6-tribromophenol from phenol.
- (iv) Diazotization/coupling - Preparation of methyl orange and methyl red.
- (v) Oxidation : Preparation of benzoic acid from toluene
- (vi) Reduction : Preparation of aniline from nitrobenzene.  
Preparation of m-nitroaniline from m-dinitrobenzene.
- (vi) (i) **Analysis by Colorimetry**
- 1. To verify Beer - Lambert law for  $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$  and determine the concentration of the given solution of the substances.
  - 2. Estimation of iron colorimetrically.
  - 3. Estimation of phosphate colorimetrically.
- (ii) **Solvent Extraction** : Separation and estimation of Mg (II) and Fe (II).
- (iii) **Ion Exchange** : Separation and estimation of Mg (II) and Zn (II).
3. **Qualitative Analysis** : Analysis of an organic mixture containing two solid components separable by water, dil.  $\text{NaHCO}_3$  and dil.  $\text{NaOH}$ .
- (ii) **Physical Chemistry Experiment** : Any one of the experiments may be given in the examination.
- Conductometry**
- To determine the strength of the given acid conductometrically using standard alkali solution.
- To determine the solubility and solubility products of a sparingly soluble electrolyte conductometrically.
- To study the saponification of ethyl acetate conductometrically.
- To determine the ionization constant of a weak acid conductometrically.
- Potentiometry**
- 7. To titrate potentiometrically the given ferrous ammonium sulphate solution using  $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$  as titrate and calculate the redox potential of  $\text{Fe}^{3+}/\text{Fe}^{2+}$  system on the hydrogen scale.
  - 8. To determine the strength of a given solution of  $\text{HCl}/\text{CH}_3\text{COOH}$  by titrating with standard  $\text{NaOH}$  solution potentiometrically/pH metrically.
- Refractometry, Polarimetry**
- (i) To verify law of refraction of mixtures (e.g. of glycerol and water) using

Abbe's refractometer.

- (ii) To determine the specific rotation of a given optically active compound.

Adulteration - Food stuffs, Effluent analysis, water analysis

### **BOOKS RECOMMENDED**

1. Practical Chemistry - Giri, Bajpai and Pandey, S. Chand & Co. Ltd., New Delhi.
2. Laboratory Manual in Organic Chemistry, R.K. Bansal, Willey Eastern.
3. Experimental Organic Chemistry, Vol. I and II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
4. Experiments in Physical Chemistry - J.C. Ghose, Bharti Bhawan.
5. Experiments in General Chemistry, N.r. Rado and U.C. Agarwal, Eastern Press.
6. Practical Chemistry - Suresh Ameta and P.b. Punjabi, Himanshu Publication.