

MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER



पाठ्यक्रम  
**SYLLABUS**

SCHEME OF EXAMINATION AND COURSES OF STUDY

**FACULTY OF SCIENCE**

**M.Sc. Chemistry**

**M.Sc. (Semester I & II)**

(w.e.f. 2015-16)

**M.Sc. (Semester III & IV)**

(w.e.f. 2016-17)

महर्षि दयानन्द सरस्वती विश्वविद्यालय, अजमेर

**NOTICE**

1. Change in Statutes/Ordinances/Rules/Regulations Syllabus and Books may, from time to time, be made by amendment or remaking, and a candidate shall, except in so far as the University determines otherwise comply with any change that applies to years he has not completed at the time of change. **The decision taken by the Academic Council shall be final.**

**सूचना**

1. समय-समय पर संशोधन या पुनः निर्माण कर परिनियमों/अध्यादेशों/नियमों / विनियमों / पाठ्यक्रमों व पुस्तकों में परिवर्तन किया जा सकता है, तथा किसी भी परिवर्तन को छात्र को मानना होगा बशर्ते कि विश्वविद्यालय ने अन्यथा प्रकार से उनको छूट न दी हो और छात्र ने उस परिवर्तन के पूर्व वर्ष पाठ्यक्रम को पूरा न किया हो। विद्या परिषद द्वारा लिये गये निर्णय अन्तिम होंगे।

**M.Sc. CHEMISTRY****SEMESTER SCHEME OF EXAMINATION**

- The maximum marks of each Semester Examination will be 300. There shall be two semesters in one year and four Semesters in all. It will be necessary for a candidate to pass in the theory as well as in the practical examination separately. Criteria for pass percentage and division will be as per the university policy for Semester Scheme prescribed uniformly by the university.
- There will be four papers in each of the four Semesters and 16 papers in all. Each paper will have maximum marks of 50 and examination will be of 3 hours duration. There will be one Practical Examination of 7 hours duration in one day with maximum of 100 marks in every Semester.
- Each theory paper is assigned four hours per week of teaching. Practical classes are assigned three continuous periods of one hour each per day (18 hours per week). Seminars are assigned two hours per week which includes seminar presentation alongwith text submission.
- Scheme of examination in Individual Semester and distribution of marks in each paper will be as under :

**Curriculum & Scheme of Examination for M.Sc. Chemistry**

Semester Number	And Paper Nomenclature	Total Marks
<b>Semester I</b>		
Paper - I	Inorganic Chemistry	50
Paper-II	Reaction Mechanism - I	50
Paper-III	Physical Chemistry - I	50
Paper-IV	Computer and Diffraction Methods	50
Paper V	Practicals (including Seminar of 15 marks)	100
		<b>Total 300</b>
<b>Semester II</b>		
Paper VI	Coordination Chemistry	50
Paper VII	Reaction Mechanism -II and Stereochemistry	50
Paper VIII	Physical Chemistry- II	50
Paper IX	Group Theory and Spectroscopy	50
Paper X	Practicals (including Seminar of 15 marks)	100
		<b>Total 300</b>
<b>Semester III</b>		
Paper XI	Spectroscopy	50
Paper XII	Photochemistry and Solid State Chemistry	50
Paper XIII	Environmental Chemistry	50
Paper XIV	Chemistry of Life	50
Paper XV	Practicals (including seminar of 15 marks)	100
		<b>Total 300</b>
<b>Semester IV</b>		
<b>Group A</b>		
Paper XVIA	Contemporary Inorganic Chemistry	50
Paper XVII A	Bioinorganic Chemistry	50

## 4. A.D.S.U. Syllabus / M.Sc. Chemistry

Paper XVIII A Advance Co-ordination Chemistry	50
Paper XIX A Inorganic Polymers	50
	200
<b>OR</b>	
<b>Group B</b>	
Paper XVI B Organic Synthesis- I	50
Paper XVII B Organic Synthesis- II	50
Paper XVIII B Heterocyclic Chemistry	50
Paper XIX B Natural Products	50
	200
<b>OR</b>	
<b>Group C</b>	
Paper XVI C Chemical Dynamics- I	50
Paper XVII C Chemical Dynamics- II	50
Paper XVIII C Electrochemistry- I	50
Paper XIX C Electrochemistry- II	50
	200
<b>OR</b>	
<b>Group D</b>	
Paper XVI D Forensic Chemistry	50
Paper XVII D Anthropometry and Toxicology	50
Paper XVIII D Methods of Instrumental Analysis	50
Paper XIX D Instrumental and Biochemical Analysis	50
	200
Paper XX Practicals (For each Group)	100
(including Seminar of 15 marks)	
<b>Total =</b>	<b>300</b>
<b>Grand Total =</b>	<b>1200</b>

**M.Sc. CHEMISTRY**  
**SEMESTER-I**

**PAPER I- INORGANIC CHEMISTRY**

**Time: 3 Hours**

**Max. Marks: 50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts; Part-A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions, two from each unit. Candidate is required to attempt three questions - one from each Unit. Each question is of ten marks (400 words.).

**Unit I**

**(a) Stereochemistry and Bonding in Main Group Compounds**

VSEPR, Irregular Geometry of molecules.  $\sigma$  bonds, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.

**(b) Metal Clusters**

Higher boranes, carboranes, metalboranes and metallocarboranes.

**Unit II**

**Fundamentals of Transition Metal Complexes**

Energy profile of reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis and conjugate base mechanism direct and indirect evidences in favour of conjugate mechanism.

**Unit III**

**Reaction Mechanism of Transition Metal Complexes**

Anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reaction, electron transfer reactions, mechanism of one electron transfer reactions, outer-sphere type reactions, cross reactions, Marcus-Hush theory, inner sphere type reactions.

**Books Suggested**

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson. John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
4. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.
5. Reaction mechanism, Basalo Pearson, Academic Press.

**PAPER II- REACTION MECHANISM-I**

**Time: 3 Hours**

**Max. Marks: 50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions- one from each Unit. Each question is of ten marks (400 words.).

**Unit I**

**(a) Nature of Bonding in Organic Molecules**

Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, bonding in fullerenes, tautomerism.

Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of  $\pi$ -molecular orbitals, annulenes, anti aromaticity, homoaromaticity, PMO approach.

Bonds weaker than covalent - addition compounds, Crown ether complexes and cryptands, inclusion compounds.

**(b) Reaction Mechanism: Structure and Reactivity**

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams.

Generation, structure, stability and reactivity of carbocations, carbanions free radicals, carbenes and nitrenes. Effect of structure on reactivity-

resonance and field effects, steric effect, the Hammett & Taft equation- linear free energy relationship, substituent and reaction constants.

#### Unit II

##### (a) Aliphatic Nucleophilic substitution

The  $S_N2$ ,  $S_N1$ , mixed  $S_N1$  and  $S_N2$  and SET mechanism

##### (b) Aromatic Nucleophilic Substitution

The  $ArS_N1$ ,  $ArS_N2$ , benzyne and  $S_{RN}1$  mechanism. Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Sommelet-Hauser and Smiles rearrangements.

##### (c) Aliphatic Electrophilic Substitution.

Bimolecular mechanism- $S_E2$  and  $S_Ei$ . The  $S_E1$  mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

##### (d) Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring system. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeier reaction, Gattermann-Koch reaction.

#### UNIT - III

##### Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvent on reactivity.

Allylic halogenations (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction. Free radical rearrangement, Hunsdiecker Reaction

##### Books Suggested

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3. A guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold Cornell University Press.
5. Organic Chemistry, T.R. Morrison and R.N. Boyd, Prentice-Hall
6. Modern Organic Reactions, H.O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
8. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.

#### PAPER III - PHYSICAL CHEMISTRY - I

Time: 3 Hours

Max. Marks: 50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is

compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

#### Unit I

##### (a) Quantum Chemistry

Schrodinger equation to some model systems viz., harmonic oscillator, the rigid rotor, hydrogen atom. Applications of variation method and perturbation theory to the helium atom.

##### (b) Molecular Orbital Theory

Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc.

#### Unit II

##### Thermodynamics

Concept of fugacity and determination of fugacity. Non-ideal systems, Excess functions for non-ideal solutions, Activity, Activity coefficient, Debye Huckel theory for activity coefficient for electrolytic solution; determination of activity and activity coefficient; ionic strength. Application of phase rule to three component system - acetic acid + chloroform + water.

#### Unit III

##### A. Chemical Dynamics

Collision theory of reaction rates, steric factor, activated complex theory, ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, methods of determining mechanism, isotope effects.

Dynamic chain (hydrogen-bromine reactions, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen-bromine reaction), acid base catalysis, kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, flash photolysis, dynamics of unimolecular reactions (Lindemann theory, Hinshelwood modifications).

##### Books Suggested :

1. Physical Chemistry, P.W. Atkins, ELBS
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3. Quantum Chemistry, Ira N. Levine, Prentice Hall.
4. Coulson's Valence, R McWeeny, ELBS
5. Chemical Kinetics, K.J. Laidler, MacGraw-Hill
6. Kinetics and Mechanism of Chemical Transformations, J. Rajaram and J. Kuriacose, McMillan.
7. Modern Electrochemistry Vol. I and Vol. II J.O.M. Bockris and A.K.N. Reddy, Plenum.
8. Phase Rule by Bowden.
9. Phase Rule by Y.K. Gupta.

**PAPER - IV COMPUTER AND DIFFRACTION METHODS****Time: 3 Hours****Max. Marks:50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part – A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**Unit I****(a) Introduction to Computers and Computing**

Basic structure and functioning of computers with a PC as an illustrative example. Memory, I/O devices. Secondary Storage. Computer language. Operating systems with DOS as an example. Introduction to UNIX and WINDOWS. Data Processing, principles of programming. Algorithms and flow-charts.

**(b) Computer Programming in C**

Overview of C, Constants, Variable and data types, Operators and expression, Managing input and output operators, Decision making and branching, IF statement, IF...ELSE statement, GO TO statement, Decision Making and Looping, WHILE statement, DO statement and FOR Statement, Jumps in loop.

**Unit-II****(a) Programming in Chemistry**

Development of small computer codes involving simple formulae in chemistry, such as Vander waals equation, titration, kinetics, radioactive decay. Evaluation of lattice energy and ionic radii from experimental data.

**(b) Electron Diffraction**

Scattering intensity vs. scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules, Low energy electron diffraction and structure of surfaces.

**(c) Neutron diffraction**

Scattering of neutrons by solids and liquids, magnetic scattering, measurement techniques. Elucidation of structure of magnetically ordered unit cell.

**Unit - III****X-ray Diffraction**

Debye-Scherrer method of X-ray structural analysis of crystal, index reflections, identification of unit cells from systematic absences in diffraction pattern. Structure of simple lattices and X-ray intensities, structural factor and its relation to intensity and electron density, phase problem. Description of the procedure for an X-ray structure analysis, absolute configuration of molecules. Ramchandran diagram.

**Books Suggested**

1. Applied Electron Spectroscopy for chemical Analysis Ed. H. Windawi and F.L. No, Wiley Interscience.
2. Physical Methods in Chemistry R.S. Drago, Saunders College.
3. Introduction to Molecular Spectroscopy, R. Chang, McGraw Hill.

**4. Programming in AnsiC-E. Balagursamy****PAPER V - PRACTICALS****Time : 07 Hours****Max Marks-100****A. Inorganic****Preparations (Any five of the following preparations)**

- (1) Tris (thiourea) copper (II) sulphate.
- (2) Cis-Potassium diaquatrioxalatochromate (III).
- (3) Sodium diamminetetrahydroxycobaltate (III).
- (4) Tris (acetylacetonato) manganese (II).
- (5) Potassium trioxalatoferate (III).
- (6) Prussian Blue.
- (7) Hexamminecobalt (III) hexanitrocobaltate (III).
- (8) Vanadyl acetylacetonate
- (9) Dichloridobis (pyridine) cobalt (II).
- (10) Hexamminenickel (II) chloride.
- (11) Bis (dimethylglyoximate) nickel (II).
- (12) Tetramminecopper (II) sulphate.

**B. Organic****(a) Qualitative Analysis**

Separation, purification and identification of compounds of binary mixture (two solids).

**(b) Quantitative Analysis (any three)**

- (i) Estimation of amines/phenols using bromide solution/or acetylation method.
- (ii) Determination of Iodine value of an oil sample.
- (iii) Determination of Acid Value of an oil sample.
- (iv) Determination of Saponification value of an oil sample.

**C. Physical Chemistry**

(Students are required to perform at least five experiments from the following experiments.)

1. Determination of the effect of (a) change of temperature (b) change of concentration of reactants and catalyst and (c) Ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reactions.
2. Determination of strength of acid in gm/l conductometrically using following combinations (i) SA-WB (ii) WA-SB (iii) WA-WB (iv) SA-SB {S-Strong, W-Weak, A-Acid, B-Base }
3. Determination of the velocity constant, order of the reaction and energy of activation of saponification of ethyl acetate by sodium hydroxide conductometrically.
4. Determination of solubility and solubility product of sparingly soluble salts (e.g.  $PbSO_4$ ,  $BaSO_4$ ) conductometrically.
5. Determination of the strength of strong and weak acids in a given mixture conductometrically.
6. To study the effect of solvent on the conductance of  $AgNO_3$ /acetic acid and to determine the degree of dissociation and equilibrium constant in different solvents and in their mixture (DMSO, DMF, dioxane, acetone,

- water) and to test the validity of Debye-Huckel-Onsager theory.
- Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.
  - Determination of the dissociation constant of monobasic/dibasic acid.

**Books Suggested :**

- Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, E.I.B.S.
- Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.
- Experiments and Techniques in Organic Chemistry, D.Past, C.Johnson and M. Miller, Prentice Hall.
- Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Health.
- Systematic Qualitative Organic Analysis, H. Mideleton, Adward Arnold.
- Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
- Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell John Wiley.
- Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
- Findley's Practical Physical Chemistry, B.P. Levitt, Longman.
- Experiments in Physical Chemistry, R.C. Das and B. Behera. Tata McGraw Hill.

**INSTRUCTIONS FOR PRACTICALS****Max Marks: 100****Time: 07 Hours**

The Board of Examiners will constitute of one External Examiner and one Internal Examiner.

**Marks**

<b>(A) Inorganic</b>	
Inorganic Preparations	- 15
<b>(B) Organic</b>	
(a) Qualitative Analysis	- 15
(b) Quantitative Analysis	- 15
<b>(C) Physical</b>	
1. One experiment is to be performed	- 20
<b>(D) Viva</b>	- 10
<b>(E) Record</b>	- 10
<b>(F) Seminar</b>	- 15
<b>Grand Total</b>	<b>100</b>

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**M.Sc. CHEMISTRY**  
**SEMESTER-II**

**PAPER VI - COORDINATION CHEMISTRY**

**Time: 3 Hours****Max. Marks: 50**

Note : Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is

compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions- one from each Unit. Each question is of ten marks (400 words.).

**Unit I****(a) Metal-Ligand Equilibria in Solution**

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.

**(b) Metal Ligand Bonding**

Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes,  $\pi$ -bonding and molecular orbital theory

**Unit II****Electronic Spectra and Magnetic Properties of Transition Metal Complexes**

Spectroscopic ground state, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes ( $d^1$ - $d^9$  states). Calculations of  $Dq$ ,  $B$  and  $\beta$  parameters, charge transfer spectra, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

**Unit III****Metal  $\pi$ -Complexes.**

Metal carbonyls, structure and bonding. Vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.

**Books Suggested**

- Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson. John Wiley.
- Inorganic Chemistry, J.E. Huhey, Harpes & Row.
- Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
- Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
- Magnetochemistry, R.L. Carlin, Springer Verlag.
- Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.
- Reaction mechanism, Basalo Pearson, Academic Press.

**PAPER VII - REACTION MECHANISM - II AND STEREOCHEMISTRY****Time: 3 Hours****Max. Marks: 50**

Note : Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions- one from each



Unit. Each question is of ten marks (400 words.).

### Unit I

#### a) Addition to Carbon-Hetero Multiple Bonds

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction.

Mechanism of condensation reaction involving enolates-Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

#### b) Addition to Carbon-Carbon Multiple Bonds

Mechanism and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemo-selectivity, orientation and reactivity.

Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

### Unit II

#### (a) Stereochemistry

Elements of symmetry, chirality, molecules with more than one chiral centre, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape.

Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

(b) Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding.

### Unit III

#### Pericyclic Reactions

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reaction. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions- conrotatory and disrotatory motions,  $4n$ ,  $4n+2$  and allyl systems. Cycloadditions-antarafacial and suprafacial additions,  $4n$ ,  $4n+2$  systems,  $2+2$  addition of ketenes, 1,3 dipolar cycloaddition and cheletropic reactions.

Sigmatropic rearrangements-suprafacial and antarafacial shifts of P sigmatropic shifts involving carbon moieties, 3,3- and 5,5-sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangements, Ene reaction.

#### Books Suggested:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advance Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3. A guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold Cornell

University Press.

5. Organic Chemistry, T.R. Morrison and R.N. Boyd, Prentice-Hall
6. Modern Organic Reactions, H.O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Profesional.
8. Pericyclic Reactions S.M. Mukherji, Macmillan, India.
9. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
10. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
11. Stereochemistry of Organic Compounds, P.S. Kalsi New Age International.

### PAPER VIII--PHYSICAL CHEMISTRY - II

Time: 3 Hours

Max. Marks:50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions- one from each Unit. Each question is of ten marks (400 words.).

### Unit I

#### Electrochemistry

Electrochemistry of solutions, Debye-Huckel-Onsager treatment and its extension, ion solvent interactions. Debye-Huckel-Bjerrum model. Thermodynamics of electrified interface equations, methods of determination. Semiconductor interfaces-theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces. Effect of light at semiconductor solution interface.

Overpotentials, exchange current density, derivation of Butler-Volmer equation, Tafel Plot.

Polarography theory, Ilkovic equation; half wave potential and its significance. Corrosion - Types, mechanism and inhibition.

### Unit II

#### Surface Chemistry

##### (a) Adsorption

Pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation without derivation), mechanism of surface catalytic reactions.

##### (b) Micelles

Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization, solubilization, micro emulsion, reverse micelles.

**(c) Macromolecules**

Electrically conducting, fire or heat resistant, liquid crystal polymers

**UNIT III****Statistical Thermodynamics**

Concept of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulate of ensemble and averaging. Canonical, grand canonical and micro canonical ensembles. Partition functions- translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions. Applications of partition functions. Chemical equilibria and equilibrium constant in terms of partition functions, Fermi-Dirac statistics.

Bose-Einstein statistics-distribution law and application to helium in brief.

**Books Suggested :**

1. Physical Chemistry, P.W. Atkins, ELBS
2. Chemical Kinetics, K.J. Laidler, MacGraw-Hill
3. Kinetics and Mechanism of Chemical transformations, J. Rajaraman and J. Kuriacose, McMillan.
4. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.
5. Modern Electrochemistry Vol. I and Vol. II J.O.M. Bockris and A.K.N. Reddy, Plenum.
6. Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.

**PAPER IX - GROUP THEORY AND SPECTROSCOPY****Time: 3 Hours****Max. Marks: 50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions- one from each Unit. Each question is of ten marks (400 words.).

**Unit I****(a) Symmetry and Group Theory in Chemistry**

Symmetry elements and symmetry operation, definitions of group, sub-group, relation between orders of a finite group and its subgroup Conjugacy relation and classes. Point symmetry group.

**(b) Raman Spectroscopy**

Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, mutual exclusion principle. Resonance, Raman spectroscopy, coherent anti Stokes Raman spectroscopy (CARS).

**Unit II****(a) Molecular spectroscopy**

Energy levels, molecular orbitals, vibrational transitions, vibration progression and geometry of the excited states, Franck-Condon Principle, electronic spectra of

polyatomic molecules, Emission spectra, radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.

**(b) Photoelectron Spectroscopy**

Basic principles; photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules. ESCA. Chemical information from ESCA. Auger electron spectroscopy-basic idea.

Photoacoustic Spectroscopy, Basic principle of photoacoustic spectroscopy (PAS), PAS-gases and condensed systems, chemical and surface applications.

**Unit III****Electron Spin Resonance Spectroscopy**

Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the "g" value. Isotropic and anisotropic hyperfine coupling constants, spin Hamiltonian, spin densities and McConnell relationship, measurement techniques, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as  $\text{PH}_2$ ,  $\text{F}_2$  and  $[\text{BH}_2]$ .

**Books Suggested**

1. Modern Spectroscopy, J.M. John Wiley.
2. Applied Electron Spectroscopy for chemical Analysis Ed. H. Windawi and F.L. No, Wiley Interscience.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
4. Physical Methods in Chemistry R.S. Drago, Saunders College.
5. Chemical Application of Group Theory, F.A. Cotton.
6. Introduction to Molecular Spectroscopy, R. Chang, McGraw Hill.
7. Basic Principles of Spectroscopy, R. Chang, McGraw Hill
8. Introduction of Photoelectron Spectroscopy, P.K. Ghosh, John Wiley.
9. Introduction to Magnetic Resonance., A Carrington and A.D. Carrington and A.D. MacLachlan, Harper & Raw.

**PAPER X-PRACTICALS****Time : 07 Hours****Max Marks-100****A. Inorganic**

Separation and determination of two metal ions Cu-Ni, Ni-Mg, Cu-Fe, Cu-Ba etc. involving volumetric and gravimetric methods.

**B. Organic****(a) Organic Synthesis (any five)**

- (i) Acetylation: Acetylation of cholesterol and separation of cholesteryl acetate by column chromatography.
- (ii) Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol.
- (iii) Aldol condensation: Dibenzal acetone from benzaldehyde.
- (iv) Sandmeyer reaction: p-Chlorotoluene from p-toluidine.
- (v) Cannizzaro reaction: 4-Chlorobenzaldehyde as substrate.
- (vi) Friedel Crafts Reaction:  $\beta$ -Benzoyl propionic acid from succinic anhydride and benzene.



- (vii) Aromatic electrophilic substitutions: Synthesis of p-nitroaniline and p-bromoaniline

**(b) Quantitative Analysis (any two)**

- (i) Determination of DO of a water sample.  
 (ii) Determination of COD of a water sample.  
 (iii) Determination of BOD of a water sample.

**C. Physical Chemistry**

(Students are required to perform at least five experiments from the following experiments.)

- Determination of congruent composition and temperature of a binary system (e.g. diphenylamine-benzophenone system).
- To construct the phase diagram for three component system (e.g., chloroform-acetic acid-water).
- Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
- Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as an iodine clock reaction.
- Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodine ion is oxidized by persulphate ion).
- Determination of strengths of halides in a mixture potentiometrically.
- Determination of the strengths of strong and weak acids in a given mixture using a potentiometer/pH meter.
- Determination of the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometrically.
- Acid-base titration in a non-aqueous media using a pH meter.
- Determination of activity and activity coefficient of electrolytes.
- Determination of partition coefficient of  $I_2$  between water and  $CCl_4$ .

**INSTRUCTIONS FOR PRACTICALS****Max Marks: 100****Time: 07 Hours**

The Board of Examiners will constitute of one External Examiner and one Internal Examiner.

**Marks****(A) Inorganic**

Separation and determination of two metals involving volumetric and gravimetric methods. - 20

**(B) Organic**

(a) Organic Synthesis - 10  
 (b) Quantitative Analysis - 15

**(C) Physical**

1. One experiment is to be performed - 20

(D) Viva - 10

(E) Record - 10

(F) Seminar - 15

Grand Total 100

**M.Sc. CHEMISTRY****SEMESTER III****PAPER XI - SPECTROSCOPY****Time: 3 Hours****Max. Marks: 50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C: Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**UNIT-I** **$^{13}C$  NMR Spectroscopy**

Difficulties and solution for recording  $^{13}C$ -NMR spectra, recording of  $^{13}C$ -NMR spectra - scale, solvent, solvent signals and their positions, multiplicity,  $^{13}C$ - $^1H$  coupling constant - proton coupled and decoupled  $^{13}C$  spectra, broad band decoupling, off resonance technique. Chemical shifts in  $^{13}C$  spectra - chemical shift calculation for alkanes, alkenes and alkynes, chemical shift calculation in internal and terminal substituted compounds, aromatic compounds. Use of  $^{13}C$  spectra in differentiating stereoisomers, Nuclear Overhauser Effect.  $^{13}C$ -Dept Spectra- Differentiation in primary, secondary and tertiary carbons by Dept -45, Dept-90, Dept-135 Spectra.

**$^2D$  NMR Spectroscopy:** Theory and Principles of  $^2D$  NMR Spectroscopy, Interpretation of  $^1H$ - $^1H$  COSY,  $^1H$ - $^{13}C$  Hetero, HMQC, HMBC, Inadequate Spectra.

**UNIT-II****Mass Spectroscopy**

Introduction, ion production-EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, Mc Lafferty rearrangement. Nitrogen rule. High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

**Unit III****Applications of spectroscopy**

UV-Visible, IR,  $^1H$  NMR,  $^{13}C$  NMR, MASS-interpretation of common organic compounds.

**Books Suggested :**

- Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
- Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.
- NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Horwood.
- Practical NMR Spectroscopy, M.L. Martin, J.J. Delpuech and G.J. Martin, Heyden.

- Spectrometric identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley.
- Introduction to NMR Spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley.
- Application of Spectroscopy of organic Compounds, J.R. Dyer, Prentice Hall.
- Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming Tata McGraw Hill.

**PAPER XII - PHOTOCHEMISTRY AND SOLID STATE CHEMISTRY****Time: 3 Hours****Max. Marks:50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**UNIT-I****Electronic Properties and Band Theory**

Metals, Insulators and semiconductors, electronic structure of solids-band theory. Band structure of metals. insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junction.

**Super conductors-Definition types and BCS theory**

Optical properties-optical reflectance, photoconduction-photoelectric effects. Magnetic Properties-Classification of materials -magnetic domains, hysteresis.

**UNIT-II****(a) Photochemical Reactions**

Interaction of electromagnetic radiation with matter, type of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

**(b) Determination of Reaction Mechanism**

Classification, rate constants. and life time of reactive energy state-determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Type of photochemical reactions-photo-dissociation, gas-phase photolysis.

**(c) Photochemistry of Alkenes.**

Intermolecular reactions of the olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1, 4- and 1, 5-dienes.

**UNIT-III****(a) Photochemistry of Carbonyl Compounds**

Intramolecular reactions of the carbonyl compounds- saturated, cyclic and acyclic,  $\beta,\gamma$ -unsaturated and  $\alpha, \beta$ -unsaturated compounds, cyclohexadienones. Intermolecular cycloaddition reactions-dimerisation and oxetane formation.

**(b) Photochemistry of Aromatic Compounds**

Isomerisations, additions and substitutions.

**(c) Miscellaneous Photochemical Reactions**

Photo-Fries reactions of anilides. Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photo degradation of polymers. Photochemistry of vision.

**Books Suggested:**

- Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Craddock, EIBS.
- Progress in Inorganic Chemistry vol., 8<sup>th</sup> ed., F.A. Cotton, vol. 15, ed. S.J. Lippard, Wiley.
- Transition Metal Chemistry ed.R.L. Carlin vol. 3, Dekker.
- Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.
- Fundamentals of Photochemistry, K.K. Rohtagi-Mukherji, Wiley-Eastern.
- Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Scientific Publication.
- Molecular Photochemistry, N.J. Turro, W.A. Benjamin.
- Introductory Photochemistry, A. Cox and T. Camp. Mc-Graw Hill.
- Photochemistry, R.I.P. Kundall and A. Gilbert, Thomson Nelson.
- Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.

**PAPER XIII - ENVIRONMENTAL CHEMISTRY****Time: 3 Hours****Max. Marks:50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**UNIT-I****(a) Air**

Chemical composition of atmosphere, ions and radicals and their formation, chemical and photochemical reactions in atmosphere. Greenhouse effect, acid rain, ozone hole phenomenon, temperature inversion.

Source and toxic effects of Pb, Cd, Hg, As, Cr, Ni and Mn.

**(b) Air Pollution**

Classification of air pollutants - sources, effects and control of CO, SO<sub>2</sub>, NO, HC as gaseous pollutants, suspended particulate matter aerosols, photochemical air pollution.

**UNIT-II****(a) Water**

Water quality parameters and their analysis, treatment of drinking water and waste water.

**(b) Water Pollution**

Sources of water pollution-solid waste, industrial, agricultural, oil, radioactive waste, thermal pollution classification of water pollutants-basis, effects and controls. Sampling of water pollutants.

## UNIT-III

**Soil and Soil Pollution**

Chemical profile of soils, definition, fertility management of soils, soil sediment analysis-physical and chemical parameters.

Soil pollution-sources, detrimental effects and control.

**Books Suggested:**

1. Environmental Chemistry, S.E. Mannahan, Lewis Publishers.
2. Environmental Chemistry, Sharma & Kaur, Krishna Publishers.
3. Environmental Chemistry, A.K. De, Wiley Eastern.
4. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern.
5. Standard Method of Chemical Analysis. F.J. Welcher Vol.III Van Nostrand Reinhold Co.
6. Element Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.
7. Environmental Chemistry, C. Baird, W.H. Freeman.

**PAPER XIV-CHEMISTRY OF LIFE**

Time: 3 Hours

Max. Marks:50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C, Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**Unit-I**

- (a) **Metals (Mg, Ca, Mn, Fe and Co) in Biological Systems**  
Definition and classification of metals
- (b) **Na<sup>+</sup>/K<sup>+</sup> Pump**  
Role of bulk and trace metals ions in biological processes.
- (c) **Bioenergetics**  
Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.
- (d) **Cell Membrane and Transport of Ions**  
Ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport. Nerve conduction.

**Unit II**

- (a) **Enzymes**  
Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis; concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-Menten kinetics and Michaelis constant, Lineweaver-Burk Plots, reversible and irreversible inhibition.

**(b) Mechanism of Enzyme Action**

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Example of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

**Unit III****(a) Co-Enzyme Chemistry**

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD<sup>+</sup>, NADP<sup>+</sup>, FMN, FAD, lipoic acid, Vitamin B<sub>12</sub>.

**(b) Biotechnical Application of Enzymes**

Use of enzymes in food and drink industry-brewing and cheese making, syrups from corn starch, enzymes as targets for drug design, recombinant DNA technology.

**Books Suggested**

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
3. Inorganic Biochemistry vols I and II G.L. Eichhorn, Elsevier.
4. Progress in Inorganic Chemistry, Vols 18 and 38 ed. J.J. Lippard, Wiley.
5. Bioorganic Chemistry: A Chemical Approach to Enzyme Action. H. Dugas and C. Penny, Springer verlag.
6. Understanding Enzymes, Trevor Palmer, Prentice Hall.
7. Enzyme Chemistry: Impact and Applications, Ed. Collin J. Suckling, Chapman and Hall.
8. Fundamental of Enzymology, N.C. Price and L. Stevens. Oxford University Press.
9. Immobilized Enzymes: An introduction and Application in Biotechnology. Michael D. Trevan. John Wiley.
10. Enzymatic Reaction Mechanisms, C. Walsh, W.H. Freeman.
11. Enzyme Structure and Mechanism, A Fersht, W.H. Freeman.
12. Biochemistry: The chemical reactions of Living Cells, D.E. Metzler, Academic Press.
13. Enzyme Mechanisms Ed. M.I. Page and A Williams, Royal Society of Chemistry.
14. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
15. Biochemistry, L. Stryer. W.H. Freeman
16. Biochemistry, J. David Rawn. Neil Patterson.
17. Biochemistry, Voet and Voet, John Wiley.
18. Outline of Biochemistry. E.E. Conn and P.K. Stumpf, John Wiley.
19. Bioorganic Chemistry: A chemical Approach to Enzyme Action. H. Dugas and C. Penny, Springer-Verlag.
20. Macromolecules: Structure and Function, F. Wold, Prentice Hall.

## PAPER XV-PRACTICALS

Time : 07 Hours

Max Marks-100

## A. Inorganic

## (a) Inorganic Preparations- (Any Seven)

1. Sodium amide Inorg. Synth., 1946,2,128.
2. Synthesis and thermal analysis of Group II metal oxalate hydrate. J.Chem. Ed., 1988,65,1024.
3. Atomic absorption analysis of Mg and Ca.
4. Trialkoxyboranes -Preparation, IR and NMR spectra.
5.  $\text{PhBcl}_2$  dichlorophenylborane-Synthesis in vacuum line.
6. Preparation of Tin (IV) iodine, Tin (IV) chloride and Tin (II) iodide. Inorg. Synth., 1953,4,119.
7. Relative stability of Tin (IV) and Pb(IV). Preparation of ammonium hexachlorostannate  $(\text{NH}_4)_2 \text{SnCl}_6$ , Ammonium hexachloroplumbate  $(\text{NH}_4)_2 \text{PbCl}_6$ .
8. Hexa-bis(4-nitrophenoxy) cyclotriphosphazene.
9. Synthesis of trichlorodiphenylantimony(V) hydrate. Inorg Synth. 1985,23,194.
10. Sodium tetrathionate  $\text{Na}_2\text{S}_4\text{O}_6$ .
11. Metal complexes of dimethyl sulfoxide(IR):  $\text{CuCl}_2 \cdot 2\text{DMSO}$ ,  $\text{PbCl}_2 \cdot 2\text{DMSO}$ ,  $\text{RuCl}_3 \cdot 4\text{DMSO}$ . J. Chem Educ., 1982,59,57.
12. Synthesis of acetylacetonate: Magnetic moment, IR, NMR, Inorg. Synth, 1957,5,130;1963,1,183.
13. Bromination of  $\text{Cr}(\text{acac})_3$ . J.Chem. Edu., 1986, 63,90.
14. Magnetic moment of  $\text{Cu}(\text{acac})_2 \cdot \text{H}_2\text{O}$ .
15. Cis and Trans  $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ .
16. Separation of optical isomer of cis- $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ . J.Chem. Soc. 1960, 4369.
17. Ion exchange separation of oxidation state of vanadium. J. Chem. Educ., 1980, 57, 316;1975,55,55.
18. Determination of Cr(III) complexes.  $\text{Cr}(\text{H}_2\text{O})_6\text{NO}_3 \cdot 3\text{H}_2\text{O}$ ,  $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$ ,  $[\text{Cr}(\text{en})_3]\text{Cl}_3 \cdot \text{C}(\text{acac})_3$ . Inorg. Synth., 1972,13,184.
19. Preparation of N, N bis(salicylaldehyde) ethylenediamine, salen  $\text{H}_2$ ,  $\text{Co}(\text{salen})$ . J.Chem. Educ., 1977, 54, 443, 1973, 50, 670.  
Determination of  $\text{O}_2$  absorption by  $\text{Co}(\text{salen})\text{Acct}$ . Chem. Res., 1975, 8,384.  
Reaction of Oxygen adduct with  $\text{CHCl}_3$  (deoxygenation).
20. Preparation of Fe(II), chloride (use it as Friedel-Craft chlorination source J.Org. Chem. 1978, 43,2423; J.Chem.Edu. 1984,61,645; 1986,63,361.
21. Reaction of Cr (III) with a multidentate ligand: a kinetics experiments (visible spectra Cr-EDTA complex) J.A.C.S. 1953, 75, 56, 70.
22. Preparation of  $[\text{Co}(\text{phenanthroline-5,6-quinone})]$ .
23. Preparation and use of Ferrocene. J.Chem. Edu, 1966, 43,73; 1976,53, 730.
24. Preparation of copper glycine complex-cis and trans bis(glycinato copper (II). J.Chem. Soc. dalton, 1979,1901. J.Chem. Edu. 1982,59,1052.
25. Preparation of Phosphine  $\text{Ph}_3\text{P}$  and its transition metal complexes.

26. Conversion of p-xylene to terephthalic acid catalyzed by  $\text{CoBr}_2$  (homogeneous catalysis)

## B. Organic Chemistry

## Qualitative Analysis-

Separation, purification and identification of the components of mixture of three organic compounds (three solids or two liquids and one solid, two solids and one liquid) using TLC for checking the purity of the separated compounds, chemical analysis.

## C. Physical

## Physical Experiments

## Major-

1. Determination of partial molar volume of solute and solvent in a binary mixture.
2. Determination of the temperature dependence of the solubility of a compound in two solvents having similar intermolecular interactions (benzoic acid in water and in DMSO - water Mixture) and calculate the partial molar heat of solution.
3. Determination of dissolved oxygen in aqueous solution of organic solvents
4. To study the effect of addition of an electrolyte on the solubility of an organic acid.
5. To determine the composition of binary mixtures containing  $\text{K}_2\text{Cr}_2\text{O}_7$  and  $\text{KMnO}_4$  using a spectrophotometer.
6. To determine the heats of neutralisation of two acids eg  $\text{HCl}$  &  $\text{CH}_3\text{COOH}$  and hence their relative strength.

## Minor-

1. Response characteristics of RC network.
2. Response characteristics of LR network.
3. Verification of Kirchoff's law.
4. Half wave and full wave rectifier.
5. Clipping and Clamping circuits.

## INSTRUCTIONS FOR PRACTICALS

Max Marks: 100

Time: 07 Hours

The Board of Examiners will constitute of one External Examiner and one Internal Examiner.

	Marks
(A) Inorganic	
Inorganic preparations.	-15
(B) Organic	
Qualitative Analysis	- 25
(C) Physical	
1. One experiment is to be performed from major and one from minor	
Major	- 20
Minor	- 05
(D) Viva	- 10
(E) Record	- 10



(F)Seminar	- 15
Grand Total	100

**M.SC.CHEMISTRY  
SEMESTER-IV  
GROUP-A**

**PAPER XVIIA-CONTEMPORARY INORGANIC CHEMISTRY****Time: 3 Hours****Max. Marks:50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**Unit-I**

- (a) **Alkyls and Aryls of Transition Metals**  
Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.
- (b) **Compounds of Transition Metal-Carbon Multiple Bonds**  
Alkylidenes, alkylidynes, low valent carbenes and carbynes-synthesis, nature of bond, structural characteristics, nucleophilic reactions on the ligands, role in organic synthesis. Compounds with metal-metal multiple bonds.

**Unit-II**

- (a) **Transition Metal  $\pi$ -Complexes**  
Transition Metal  $\pi$ -Complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features, Important reactions related to nucleophilic and electrophilic attack on ligands and applications in organic synthesis

**Unit III**

- (a) **Fluxional Organometallic Compounds**  
Fluxionality and dynamic equilibria in compounds such as  $\eta^2$ -olefin,  $\eta^3$ -allyl and dienyl complexes.
- (b) **Homogenous Catalysis**  
Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reactions), Oxopalladation reactions, activation of C-H bond.

**Books Suggested :**

- Principles and Application of Organotransition Metal Chemistry. J.P. Collman, L.S. Hegdus, J.R. Norton and R.G.Finke, University Science Books.
- The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.

- Metallo-Organic Chemistry, A.J. Pearson, Wiley.
- Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.

**PAPER XVIIIA-BIOINORGANIC CHEMISTRY**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**Time: 3 Hours****Max. Marks:50****Unit-I****(a) Metalloenzymes and their role in biological systems**

Zinc enzymes-carboxypeptidase and carbonic anhydrase. Iron enzyme catalyses, peroxidase and cytochrome P-450. Copper enzyme- superoxide dismutase. Molybdenum oxatransferase enzyme-xanthine oxidase, Coenzyme, Vitamin B<sub>12</sub>

**(b) Metals In Medicines**

Metals deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.

**Unit-II**

- (a) **Metal Storage Transport and Biomineralization with reference to Ferritin, transferrin, and siderophores.**

**Unit III**

Oxygen transport and oxygen uptake proteins. Basic requirement for effective oxygen carriers, biological oxygen carriers. Haemoglobin (Hb) and Myoglobin (Mb) in oxygen transport mechanism. Structural feature of Heme group in Hb and Mb. Functions of Hb and Mb. Characteristics of oxygen binding interactions with Hb and Mb.

**Books Suggested:**

- Bioinorganic Biochemistry, I. Bertini, H.B. Gray, S.J. Valentine, University Science Books.
- Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
- Inorganic Biochemistry Vols I and II. ed. G.L. Eichhorn Elsevier.
- Progress in Inorganic Chemistry, Vols 18 and 38 ed. J.J. Lippard, Wiley.

**PAPER XVIIIA-ADVANCE COORDINATION CHEMISTRY****Time: 3 Hours****Max. Marks:50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from

each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**Unit-I****Supra molecular Chemistry (Concepts and language)**

- (i) Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of co-receptor molecules and multiple recognition.
- (ii) Supra molecular reactivity and catalysis.
- (iii) Transport processes and carrier design.
- (iv) Supra molecular devices-electronic, ionic and switching, supra molecular photochemistry, some examples of self-assembly in supra molecular chemistry.

**Unit II****(a) Excited States of Metal Complexes**

Excited states of metal complexes: comparison with organic compounds, electronically excited states of metal complexes, charge-transfer spectra, charge transfer excitations, methods for obtaining charge-transfer spectra.

**(b) Metal complex Sensitizers**

Metal complex sensitizer, electron relay, metal colloid system, semiconductor supported metal or oxide system, water photolysis, nitrogen fixation and carbon dioxide reduction.

**Unit III****(b) Redox Reactions by Excited Metal Complexes**

Energy transfer under conditions of weak interaction and strong interaction-exiplex formation; conditions of the excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates (2,2'-bipyridine and 1,10 phenanthroline complexes), illustration of reducing and oxidising character of Ru (II) (bipyridal complex, comparison with Fe(bipy)<sub>3</sub>, role of spin-orbit coupling-life time of these complexes. Application of redox processes of electronically excited states for catalytic purposes, transformation of low energy reactants into high energy products, chemical energy into light.

**Books Suggested :**

1. Supramolecular Chemistry, J.M.Lehn, VCH.
2. Supramolecular and Bioinorganic Chemistry. By Dr. AK Goswami & Dr. Rekha Dashora, Pragati Prakashan
3. Principles and Application of Organotransition Metal Chemistry. J.P. Collman, L.S. Hegus, J.R. Norton and R.G.Finke, University Science Books.
4. The Organometallic Chemistry of the Transition Metals, H.R. Crabtree, John Wiley.
5. Metallo-Organic Chemistry, A.J. Pearson, Wiley.
6. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
7. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.

8. Bioinorganic Biochemistry, I. Bertini, H.B. Gray, S.J. Valentine, University Science Books.
9. Inorganic Biochemistry vols I and II. Ed. G.L. Eichhorn Elsevier.
10. Progress in Inorganic Chemistry. Vols 18 and 38 ed. J.J. Lippard, Wiley.
11. Supramolecular Chemistry, J.M.Lehn, VCH.
12. Concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley.
13. Inorganic Photochemistry, J.Chem. Educ. Vol.60, no, 10, 1983.
14. Progress in Inorganic Chemistry, vol30, ed. S.J. Lippard, Wiley.
15. Coordination Chem. Revs., 1981, vol.39, 121, 131; 1975, 15, 321; 1990, 97 313.
16. Photochemistry of Coordination Compounds, V. Balzari and V. Carassiti, Academic Press.
17. Elements of Inorganic Photochemistry, G.J.Ferraudi, Wiley.

**PAPER XIXA--INORGANIC POLYMERS.****Time: 3 Hours****Max. Marks:50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**Unit I****(a) Basics of Polymers**

Importance of polymers. Basic concepts: monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition, radical chain-ionic and co-ordination and co-polymerization. Polymerization conditions, polymer reactions and kinetics of polymerization. Polymerization in homogeneous and heterogeneous systems.

**(b) Polymer Characterization**

Poly dispersion-average molecular weight concept. Number, weight and viscosity average molecular weights. Poly dispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weights. End-group, viscosity, light scattering, osmotic and ultracentrifugation methods. Analysis and testing of polymers-chemical analysis of polymers, spectroscopic methods, X-ray diffraction study, microscopy. thermal analysis and physical testing-tensile strength, fatigue, impact, tear resistance, hardness and abrasion resistance.

**Unit II****(a) Structure and Properties of Polymers**

Morphology and order in crystalline polymers-configurations of polymer chains. Crystal structure of polymers. Morphology of crystalline polymers, strain induced morphology, crystallization and melting. Polymer structure and physical properties- crystalline melting point (T<sub>m</sub>) melting points of homogeneous series,



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effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, ( $T_g$ ) Relationship between  $T_m$  and  $T_g$ , effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking. Property requirements and polymer utilization.

## Unit III

## (b) Polymer Processing

Plastics, elastomers and fibers. Compounding. Processing techniques: calendaring, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, reinforcing and fiber spinning.

## (c) Properties of Commercial Polymers

Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers-Fire retarding polymers and electrically conducting polymers. Biomedical polymers-contact lens, dental polymers, artificial heart, kidney, skin and blood cells.

## Books Suggested :

1. Text book of Polymer Science, F.W. Billmeyer Jr, Wiley.
2. Polymer Science, V.R. Gowarikar, N.V. Vuswanathan and J. Srcehdhar, Wiley-Eastern.
3. Functional Monomers and Polymers, K. Takemoto, Y. Inaki and R.M. Otanbrite.
4. Cotemporary Polymer Chemistry, H.R. Alcock and F.W. Lambe, Prentice Hall.
5. Physics and Chemistry of Polymers, J.M.G. Cowie, Blackie Academic and Professional.

## GROUP-B

## PAPER XVI B-ORGANIC SYNTHESIS- I

Time: 3 Hours

Max. Marks:50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

## Unit-I

## (a) Oxidation

Introduction, Different Oxidative processes.

Hydrocarbons-alkenes, aromatic rings, saturated C-H groups (activated and inactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxylic acids. Amines, hydrazines and sulphides.

## (b) Reduction

Introduction, Different reductive processes.

Hydrocarbons-alkanes, alkenes, alkynes and aromatic rings, Carbonyl compounds-aldehydes, ketones. Acids and their derivatives. Epoxides.

## Unit-II

## Rearrangements

General mechanistic considerations-nature of migration migratory aptitude, memory effects.

A detailed study of the following rearrangements:

Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Beckmann, Hofmann, Curtius, Schmidt, Baeyer-Village, Shapiro reaction.

## Unit III

## (a) Organometallic Reagents

Principles, preparations, properties and applications of the following in organic synthesis with mechanistic details.

## (i) Group I and II metal organic compounds

Li, Mg, Hg, Cd, Zn Compounds

## (ii) Transition Metals

Cu, Pd, Ni, Fe, Co, Rh, Cr and Ti Compounds.

## (b) Protecting Groups

Principle of Protection of alcohol, amine, carbonyl and carboxyl groups.

## Books Suggested

1. Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
2. Some Modern methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, John Wiley.
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
5. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.
6. Rodd's Chemistry of Carbon Compounds, ed. S. Coffey, Elsevier.
7. Designing Organic Synthesis. S. Warren, Wiley.
8. Organic Synthesis - Concept, methods and starting Materials. J. Fuhrhop and G.Penzillin, Veriarge VCH.

## PAPER XVII B-ORGANIC SYNTHESIS- II

Time: 3 Hours

Max. Marks:50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

## Unit-I

## (a) One Group C-C Disconnections

Alcohols and carbonyl compounds, regioselectivity. Alkene Synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

## (b) Two Group C-C Disconnections

Diels-Alder reaction, 1,3-difunctionalised compounds.  $\alpha$ ,  $\beta$ -

unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalized compounds. Michael addition and Robinson annelation.

#### Unit-II

#### Synthesis of Some Complex Molecules

Application of disconnection approach in the synthesis of following compounds: Camphor, Longifoline, Cortisone, Reserpine, Vitamine D, Juvabione, Aphidicolin and Fredericamycin A.

#### Unit-III

#### (d) Ring Synthesis

Saturated heterocycles, synthesis of 3-, 4-, 5- and 6-membered rings, aromatic heterocycles in organic synthesis.

#### Books Suggested

1. Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
2. Some Modern methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, John Wiley.
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
5. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.
6. Rodd's Chemistry of Carbon Compounds, ed. S. Coffey, Elsevier.
7. Designing Organic Synthesis. S. Warren, Wiley.
8. Organic Synthesis - Concept, Methods and starting Materials. J. Fuhrhop and G. Penzillin, Verlage VCH.

### PAPER XVIII B - HETEROCYCLIC CHEMISTRY

Time: 3 Hours

Max. Marks: 50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

#### Unit-I

#### (a) Nomenclature of Heterocycles

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles.

#### (b) Aromatic Heterocycles

General chemical behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in  $^1\text{H}$  NMR-spectra, empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations.)

Heteroaromatic reactivity and tautomerism in aromatic heterocycles.

#### (c) Non Aromatic Heterocycles

Strain-bond angle and torsional strains and their consequences in small ring heterocycles.

Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction.

Stereo-electronic effects-anomeric and related effects. Attractive interactions-hydrogen bonding and intermolecular nucleophilic-electrophilic interactions.

#### Unit II

#### (a) Heterocyclic Synthesis

Principles of heterocyclic synthesis involving cyclization reaction and cycloaddition reactions.

#### (b) Small Ring Heterocycles

Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, azetidines, oxetanes.

(c) Heterocyclic Systems containing P - Heterocyclic ring containing phosphorus: Introduction, nomenclature, synthesis and characteristics of 5- and 6- membered ring systems-phosphorinanes, phosphorines, phospholanes and phospholes.

#### (d) Six-Membered Heterocycles with one Heteroatom

Synthesis and reactions of quinolizinium and benzopyrylium salts, coumarins and chromones.

#### Unit III

#### (a) Benzo Fused Five-membered Heterocycles

Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes. Meso-Ionic heterocycles.

#### (b) Seven -and Large-membered Heterocycles

Synthesis and reactions of azepines, oxepines, thiepinines, diazepines thiazepines, diazocines, dioxocines.

#### (c) Six-Membered Heterocycles with Two or More Heteroatoms

Synthesis and reactions of tetrazines and thiazines.

#### Books Suggested :

1. Heterocyclic Chemistry Vol. 1-3, R.R. Gupta, M.Kumar and V. Gupta, Springer Verlag.
2. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
4. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical.
5. Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.
6. An introduction to the Heterocyclic Compounds, R.M. Acheson, John Wiley.
7. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Reeds, eds. Pergamon Press.
8. Organic Chemistry, Vol.2, I.L. Finar, ELBS.

### PAPER XIX B - NATURAL PRODUCTS

Time: 3 Hours

Max. Marks: 50

Note : Paper is divided into three independent units. The question paper is

divided into three parts Part – A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

## Unit-I

## (a) Terpenoids and Carotenoids

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule.

Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Citral, Geraniol,  $\alpha$ -Terpeneol, Menthol, Farnesol, Santonin, Phytol, Abietic acid and  $\beta$ -Carotene.

## (b) Alkaloids

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants.

Structure, Stereochemistry, synthesis and biosynthesis of the following:

Ephedrine, Nicotine, Atropine, Quinine and Morphine.

## Unit II

## (a) Prostaglandins

Occurrence, Nomenclature, Classification, biogenesis and physiological effects. Synthesis of PGE<sub>2</sub> and PGF<sub>2 $\alpha$</sub> .

## (b) Pyrethroids and Rotenones

Synthesis and reactions of Pyrethroids and Rotenones.

(For structure elucidation, emphasis is to be placed on the use of spectral parameters wherever possible.)

(c) Steroids - Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereo chemistry isolation, structure determination and synthesis of Cholesterol, Bile acids, androsterone, estosterone, Estrone, Progesterone, Aldosterone. Biosynthesis of Steroids.

## Unit III

## (a) Plant Pigment

Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Quercetin, Myrcetin, Diadzein, Butein, Cycanidin, Hirsutidin.

Biosynthesis of flavonoids; Acetate pathway and Shikimic acid pathway.

(b) Porphyrins-Structure and synthesis of Haemoglobin and Chlorophyll.

## Books Suggested :

1. Natural Products: Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B.Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.
2. Organic Chemistry, Vol.2, I.L. Finar, ELBS.
3. Rodd's Chemistry of Carbon Compounds, ED. S.Coffey, Elsevier.
4. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston,

Harwood Academic Publishers.

5. Introduction to Flavonoids, B.A.Bohm, Harwood Academic Publishers.
6. New Trends in Natural Products Chemistry, Atta-ur-rahman and M.I. Choudhary, Harwood Academic Publishers.
7. Insecticides of Natural Origin, Sukhdev, Harwood Academic Publishers.

## GROUP-C

## PAPER XVI C-CHEMICAL DYNAMICS-I

Time: 3 Hours

Max. Marks:50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part – A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

## Unit-I

## (a) Inorganic Substitution Reactions

Types of substitution reaction, Langford and Gray classification of substitution mechanisms, Acid hydrolysis of aquation reaction of pentaammine cobalt(III) complexes, Base hydrolysis of chloropentaamminecobalt (III) complex.

## Unit-II

## Electron transfer reactions.

(a) Inner sphere electron transfer reactions. Henry taube's classical study of electron transfer reaction between chloropentammine cobalt (III) and Cr (II). A general mechanism involving precursor complex. Various types of bridges, Electron transfer mechanisms : adjacent attack, remote attack, resonance mechanism and chemical mechanism.

sIntra-molecular electron transfer reactions.

(b) Outer sphere electron transfer reactions. Outer sphere electron transfer mechanism Marcus cross relation and its application. Bridged outer sphere electron transfer mechanism. Kinetics of electron exchange mechanism.

## Unit-III

(a) Radiation Chemistry Introduction, sources of high energy radiation, dose, primary and secondary processes, radiolysis of water, reaction of hydrogen atoms and hydroxide radicals, radiation chemical yield.

(b) Photochemistry Unimolecular photophysical processes and their rate laws, Kinetics and mechanism of photochemical hydrogen-Bromine reaction, Kinetics of collisional quenching and Stern-Volmer equation, Semiconductor Photocatalysis-formation of hole. Excited state electron transfer reaction of [Ru(bipy)<sub>3</sub>]<sup>2+</sup> and photocatalytic splitting of water.

## Suggested books

1. Keith J. Laidler, Chemical Kinetics. Harper and Row, New York, 1987
2. Donald A Mcquarrie and John D. Simon, Physical Chemistry A Molecular approach, Viva Books, New Delhi, 2013.
3. J.E. Huheey, E.A. Keiter, O.K. Medhi, Inorganic Chemistry, Darling

- Kindersley, New Delhi, 2013
- S.K. Upadhyay, Chemical Kinetics and Reaction Mechanism, Anamya, Delhi, 2006
  - J Rajaram and J.C. Kuriacose, Kinetics and Mechanism of Chemical transformations, Mcmillan India and National Book Trust, Delhi, 1993,
  - K.K. Rohatgi-Mukherjee, Fundamentals of Photochemistry, New Age, Delhi, 1986
  - Progress in Inorganic Chemistry, Vol. 30, 1967.
  - R. Lumry and R. W. Raymond, Electron transfer Reactions, Inter science.
  - N.L. Bender, Mechanism of Homogeneous Catalysis from protein to protein Wiley.
  - A.G. Sykes, Kinetics of Inorganic reactions, Pergamon.
  - S.W. Benson, Mechanism of Inorganic Reactions, Academic Press.
  - Physical Chemistry Vol. 2 Ed. Prof. Ya Grasimov, Mir Publisher.
  - Basolo and Pearson, Inorganic Reaction Mechanism, Wiley.
  - H. Taube, Electron Transfer Reaction, Oxford Press.
  - Jingwei Luo, Allen G.Oliverb and J.Scott McIndoe , A detailed kinetic analysis of rhodium –catalyzed alkyne hydrogenation, Dalton Trans. 2013,42,11312
  - V.Y. Gankin & G.S. Gurevich, Chemical Technology of oxosynthesis , "Khimiya" (Chemistry) in Leningrad
  - F.A. Cotton, G.Wilkinson, C.A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, 6<sup>th</sup> Edn., John Wiley, Singapore , 1999.

## PAPER XVII C – CHEMICAL DYNAMICS - II

Time: 3 Hours

Max. Marks:50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part – A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

## Unit-I

## (a) Atmospheric Kinetics

Kinetics and mechanism of photodissociation of  $\text{NO}_2$  and formation of ozone in troposphere. Mechanism of Operation of  $\text{ClO}_x$  cycle in stratosphere and depletion of ozone. Mechanism and kinetics of oxidation of methane by oxygen in atmosphere, Mechanism of hydrogen-oxygen reaction.

## (b) Kinetics of gas surface reactions

Adsorption isotherms: Langmuir adsorption isotherm, Adsorption without dissociation, adsorption with dissociation, competitive adsorption; Mechanisms of surface reactions; Kinetics of unimolecular surface reactions: Inhibition,

Kinetics of bimolecular surface reactions : reaction between two adsorbed species; reactions between a gas molecule and an adsorbed molecule; reaction

between two adsorbed gases without much displacement. Kinetics and mechanism of oxidation of carbon monoxide by oxygen on a platinum surface.

## Unit-II

## (a) Enzymes kinetics

Kinetic and mechanism of one enzymes- two substrate systems  
Kinetics mechanism of inhibition of enzyme catalysis.

## (b) Micellar catalysis

Micelles - their formation and structure and CMC. Kinetics and mechanism of micelle catalyzed reactions. Different models of micellar catalysis. Micelle inhibited reactions

## Unit-III

## (a) Oscillatory Reactions

Autocatalysis and oscillatory reactions, Outline of kinetics and mechanism of Belousov-Zhabotinski (B-Z) reaction.

## (b) Induced Reactions-

Induced Reactions and their characteristics. Mechanism of iron(II) induced oxidation of iodine by chromium (IV) Mechanism of arsenic (III) induced oxidation of manganese(II) by chromium (VI) in acid solutions.

## (c) Industrial Catalysis-

Kinetics of hydroformylation reaction, kinetics of Wacker process of formation of acetaldehyde from ethylene. Kinetics of hydrogenation catalysed by Wilkinson catalyst.

## Books Suggested

- Keith J. Laidler, Chemical Kinetics. Harper and Row, New York, 1987
- Donald A Mcquarrie and John D. Simon, Physical Chemistry A Molecular approach, Viva Books, New Delhi, 2013.
- J.E. Huheey, E.A. Keiter, O.K. Medhi, Inorganic Chemistry, Darling Kindersley, New Delhi, 2013
- S.K. Upadhyay, Chemical Kinetics and Reaction Mechanism, Anamya, Delhi, 2006
- J Rajaram and J.C. Kuriacose, Kinetics and Mechanism of Chemical transformations, Mcmillan India and National Book Trust, Delhi, 1993,
- N.L. Bender, Mechanism of Homogeneous Catalysis from protein to protein Wiley.
- A.G. Sykes, Kinetics of Inorganic reactions, Pergamon.
- Physical Chemistry Vol. 2 Ed. Prof. Ya Grasimov, Mir Publisher.
- Jingwei Luo, Allen G.Oliverb and J.Scott McIndoe , A detailed kinetic analysis of rhodium –catalyzed alkyne hydrogenation, Dalton Trans. 2013,42,11312
- F.A. Cotton, G.Wilkinson, C.A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, 6<sup>th</sup> Edn., John Wiley, Singapore , 1999.

## PAPER XVIII C – ELECTRO CHEMISTRY-I

Time: 3 Hours

Max. Marks:50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part – A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one

from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

#### Unit-I

##### Conversion and storage of Electrochemical Energy:

Present status of energy consumption: Pollution problem. History of fuel cells. Direct energy conversion by electrochemical means. Maximum intrinsic efficiency of an electrochemical converter. Physical interpretation of the Carnot efficiency factor in electrochemical energy converters. Power outputs. Electrochemical Generators (Fuel Cells) Hydrogen oxygen cells, hydrogen Air cell, Hydrocarbon air cell, alkaline fuel cell, phosphoric fuel cell, direct NaOH fuel cells. Applications of fuel cells.

#### Unit-II

##### (a) Electrochemical Energy Storage:

Properties of Electrochemical energy stores; measure of battery performance. Charging and discharging of a battery. Storage density, Energy density Classical Batteries: (i) Lead-Acid (ii) Nickel-Cadmium. (iii) Zinc-Manganese dioxide.

Modern batteries: (1) Zinc-Air (ii) Nickel-Hydride, (iii) Lithium Battery.

Future electricity stores: storage in (i) Hydrogen, (ii) Alkali metals (iii) Non aqueous solutions.

#### Unit III

##### (a) Corrosion and Stability of Metals:

Civilization and surface mechanism of the corrosion of the metals, thermodynamics and the stability of metals, Potential pH (or pourbaix) Diphagrams. Uses and abuses, Corrosion current and corrosion potential-Evans diagrams.

Measurement of corrosion rate: (i) Weight loss Method (ii) Electro chemical Method.

Inhibiting corrosion: Cathodic and anodic protection (i) Inhibition by addition of substrates to the electrolyte environment (ii) by charging the corroding method from external source, anodic protection, organic inhibitors. The fuller story green inhibitors.

##### (b) Passivation:

Structure of passivation films. Mechanism of Passivation, Spontaneous Passivation: Nature's method for stabilizing surfaces.

##### Books suggested:

1. Modern Electrochemistry vol. I, IIA Vol. IIB, J'OM Bockris and A.K.N. Reddy, Plenum Publication, New York.
2. Polarographic Techniques by L. Meites, Interscience.
3. "Fuel Cells; Their electrochemistry" McGraw Hill Book Company New York.
4. Modern Polarographic Methods by A.M. Bond, Marcell Dekker.
5. Polarography and allied technique by K. Zutshi, New Age Publication. New Delhi.

6. "Electroanalytical Chemistry" by Basil H. Vessor & Galen W. Wiley Interscience.

7. Topic in Pure and Applied Chemistry. Ed. S.K. Rangrajan, SAEST Publication, Kararikudi (India).

#### PAPER XIXC-ELECTROCHEMISTRY-II

Time: 3 Hours

Max. Marks:50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

#### Unit-I

##### (a) Kinetics of Electrode Process:

Essential of electrode reaction. Current density, Overpotential. Butler Volmer equation. Standard rate constant. Transfer coefficient ( $\alpha$ ), exchange current.

(b) Irreversible Electrode Processes: Criteria of irreversible information from irreversible wave. Methods of determining kinetic parameters for quasi-reversible and irreversible waves: Koutecky's method. Meits Israel methods, Gelling's method.

#### Unit - II

(a) Bioelectrochemistry: Bio-electrodes, membrane, potentials, simplistic theory, modern theory. Electrical conductance in biological organism. Electronic, protonic electrochemical mechanism of nervous systems, enzymes as electrodes.

(b) Electro catalysis: Chemical catalysis and Electrochemical catalysis with special reference to purostates, porphyrin oxides of rare earths. Electro catalysis in simple redox reactions, in reaction involved adsorbed species, Influence of various parameters.

#### Unit-III

##### (a) Potential Sweep Method:

Linear sweep voltammetry, Cyclic voltammetry, theory and applications, Diagnostic criteria of cyclic voltammetry. Controlled current microelectrode technique, comparison with controlled potential methods Chronopotentiometry, theory and applications.

##### (b) Bulk Electrolysis Methods

Controlled potential coulometry, Controlled coulometry, Electro organic synthesis and its importance, application, stripping analysis, anodic and cathodic modes, pre electrolysis and stripping steps, application of stripping analysis.

##### Books suggested:

1. Modern Electrochemistry vol. I, IIA Vol. IIB, J'OM Bockris and A.K.N. Reddy, Plenum Publication, New York.
2. Polarographic Techniques by L. Meites, Interscience.
3. Fuel Cells; Their electrochemistry McGraw Hill Book Company New



York.

4. Modern Polarographic Methods by A.M. Bond, Marcell Dekker.
5. Polarography and allied technique by K. Zutshi, New Age Publication, New Delhi.
6. Electroanalytical Chemistry by Basil H. Vessor & Galen W. Wiley Interscience.
7. Topic in Pure and Applied Chemistry. Ed. S.K. Rangrajan, SAEST Publication, Kararikudi (India).

**GROUP-D****PAPER XVI D-FORENSIC CHEMISTRY****Time: 3 Hours****Max. Marks:50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part – A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**Unit-I**

(a) **Proteins**- Definition, classification, General properties molecular weight, denaturation, isoelectric point, coagulation of proteins, salting and salting out of proteins & reactions.

(b) **Nucleic acids** – Chemistry of purines, pyrimidine and uric acid-synthesis and uses of uracil, cytosine, thymine, adenine, guanine- isolation of caffeine from its natural source-constitution of RNA and DNA, DNA profiling. DNA finger printing.

**Unit-II**

(a) **Vitamins**-Definition, occurrence, properties and types with special reference to Vitamins A and B.

(b) **Hormones** –Definition, types, biological activities of Pituitary. Thyroid and Sex Hormones.

(c) **Blood** –General composition and Antigenic properties, Blood coagulation. Preliminary idea of Antigen, Antibody and immunological principle. Structure of antibodies. Forensic identification and grouping of Blood stains.

**Unit III**

**Identification & estimation of following narcotics** –Opium, Morphine. Heroin, Barbiturate, Cocaine and Diazepam

**PAPER XVII D-ANTHROPOMETRY AND TOXICOLOGY****Time: 3 Hours****Max. Marks:50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part – A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from

each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**Unit-I**

(a) **Introduction to body as a whole:** The various body systems and organs injuries from burn, scald, lightning, electricity, Ante mortem and post mortem burn; Injuries on road, air crash, explosion; Wound-definition, types and classification, medicological importance. Ante and post mortem wounds. Self inflicted wounds.

(b) **Alcohol & alcoholic beverages** – Manufacture of ethanol and liquors- Chemical properties and identification of alcohol, constituents of liquors- estimation of alcohol content in liquors-denaturation, denaturants, industrial alcohol and power alcohol, breath alcohol analysis, Analysis of alcohol in Blood and urine samples.

**Unit-II**

(a) **Drug action and effect** – Isolation, synthesis and estimation of alkaloids, drug dose relationship, mechanism of drug action. Absorption, distribution and elimination.

(b) **Anthropometry:** Elementary knowledge of human skeleton. Importance of anthropometry in Forensic science. Determination of height from bones. Determination of sex from bones. Age determination from cranium and other body bones. Identification of deceased by super imposition of skull. Identification of species by small bone fragments.

**Forensic odontology:** Forensic examination of semen stains. Teeth- identification, type, functions, determination of species origin and race from teeth, individualization from teeth and bite marks.

**Unit-III**

**Toxicology** Definition and general introduction to toxicology. Poisons-types, mode of action, extraction of poisons in toxicological analysis. Absorption, distribution, metabolism, chemistry of poisons, excretion of poisons. Detection and estimation of CO, Cyanide, formaldehyde, methanol, chloral, chloroform, phenols, cresols, phosphorus, As, Hg, Pb and Cd. Organophosphorus, organochlorine and carbamate pesticides and pyrethroids, corrosive poisons. Elementary knowledge of food poisoning.

**PAPER XVIII D-: METHODS OF INSTRUMENTAL ANALYSIS****Time: 3 Hours****Max. Marks:50**

**Note :** Paper is divided into three independent units. The question paper is divided into three parts Part – A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

**Unit-I**

(a) **Electron microscopy**-principle, instrumental components, transmission electron microscopy, preparation of sample with special reference to biological



tissue, applications.

Scanning electron microscopy-principle, electron specimen interactions, instrumental components, preparation of samples, applications.

Inductively coupled plasma atomic emission spectroscopy (ICPAES)- Principles and instrumentation

#### Unit II

##### Chromatography and Electrophoresis

Principle, instrumentation and application of:

Gas Chromatography

High performance liquid chromatography

Ion exchange chromatography.

Thin layer chromatography.

Electrophoresis-paper electrophoresis, thin layer electrophoresis, gel electrophoresis and immune electrophoresis.

#### Unit III

Principal, instrumentation, application of:

Atomic absorption spectrophotometry (AAS)

X-ray fluorescence spectrometry (XRF)

Radio immuno assay (RIA)

Neutron activation analysis (NAA)

#### PAPER XIX D- INSTRUMENTAL AND BIOCHEMICAL ANALYSIS

Time: 3 Hours

Max. Marks:50

Note : Paper is divided into three independent units. The question paper is divided into three parts Part - A, Part-B and Part-C. Part A (10 marks) is compulsory and contains 10 questions (50 words each). Each question is of one mark. Part-B (10 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of two marks (100 words). Part-C (30 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each Unit. Each question is of ten marks (400 words.).

#### Unit-I

(a) **Thermal Methods** - Principle, instrumentation and applications of thermogravimetry (TGA), differential thermal analysis (DTA) and differential scanning calorimetry (DSC)

(b) **Optical Methods**- Principle instrumentation and applications of refractometry, polarimetry, nephelometry and turbidimetry colorimetry.

#### Unit II

##### Analysis of biological fluids

Determination of blood group, red cell isoenzymes and serum protein in paternity determination, ABO blood group system and MNS group system. Laboratory examination of semen stain, saliva stain, urine stain.

#### Unit III

(a) **Food analysis and food adulteration** - Analysis of major and minor components of food, common adulterants in food, microscopic examination of foods for adulteration, pesticide analysis in food products.

(b) **Elements of statistics**- mean, mode, median, correlation and regression

analysis, null hypothesis, variance, t-test, chi-square test.

#### PAPER XX-PRACTICALS (FOR GROUP -A, B, C)

Time : 07 Hours

Max Marks-100

##### A. Inorganic

###### (a) Spectrophotometric Determination (Any Three)

1. Manganese/Chromium/Vanadium in steel sample.
2. Nickel/molybdenum/tungsten/vanadium/uranium by extractive spectrophotometric method.
3. Fluoride/nitrite/phosphate.
4. Iron-phenanthroline complex; Job's method of continuous variations.
5. Zirconium-Alizarin Red-S Complex; Mole-ratio method.
6. Copper-ethylene diamine complex: Slope-ratio method.

###### (b) Flame Photometric Determinations (Any Three).

1. Sodium and potassium when present together.
2. Lithium/Calcium/barium/strontium
3. Cadmium and magnesium in tap water.
4. Sulphate.
5. Phosphate
6. Silver.

###### (c). Chromatographic Separations (Any Three)

1. Cadmium and Zinc.
2. Zinc and Magnesium
3. Thin-layer Chromatography-separation of nickel, manganese, cobalt and zinc. Determination of  $R_f$  values.
4. Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of  $R_f$  values.
5. Separation and identification of Pb and Cd by Paper Chromatography and determination of  $R_f$  value.

##### B. Organic

###### (a) Organic synthesis

Multi-step Synthesis of Organic Compounds (any four)

The exercise should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.

- (i) Photochemical reaction  
Benzophenone  $\rightarrow$  benzpinacol  $\rightarrow$  benzpinacolone
- (ii) Beckmann rearrangement: benzanilide from benzene  
Benzene  $\rightarrow$  Benzophenone  $\rightarrow$  Benzophenone oxime  $\rightarrow$  benzanilide
- (iii) Benzoin  $\rightarrow$  benzil  $\rightarrow$  benzilic acid
- (iv) Preparation of Quinoline from aniline; Preparation of 2- phenylindole from phenylhydrazine.
- (v) Reduction of ethyl acetoacetate using Baker's yeast to yield enantiomeric excess of S(+) ethyl-3-hydroxybutanoate and determine its optical purity.
- (vi) Biosynthesis of ethanol from sucrose.
- (vii) Synthesis using microwave-Alkylation of diethylmalonate with benzyl chloride.
- (viii) Synthesis using phase transfer catalyst.

**Extraction of organic compound from natural source-**

1. Isolation of caffeine from tea leaves.
2. Isolation of casein from milk (the students are required to try some typical colour reactions of proteins).
3. Isolation of lactose from milk (Purity of sugar should be checked by TLC and PC and  $R_f$  (value reported).
4. Isolation of nicotine dicitrate from tobacco.
5. Isolation of cinchonine from cinchona bark.
6. Isolation of piperine from black pepper.
7. Isolation of lycopene from tomatoes
8. Isolation of  $\beta$ -carotene from carrots.
9. Isolation of oleic acid from olive oil (involving the preparation of complex with urea and separation of linoleic acid.
10. Isolation of eugenol from cloves.
11. Isolation of (+) limonine from citrus rinds.

**(b) Spectroscopy**

Identification of organic compounds by the analysis of their spectral data (UV, IR, PMR).

**Spectrometric (UV/VIS) estimations (Any Three):**

- |                  |                |
|------------------|----------------|
| 1. Aminoacids    | 2. Proteins    |
| 3. Carbohydrates | 4. Cholesterol |
| 5. Ascorbic acid | 6. Aspirin     |
7. Caffeine

**C Physical****(a) Major**

1. Determination of  $pK_a$  of indicator (e.g. methyl red).
2. Determination of stoichiometry and stability constant of inorganic (e.g. ferric-salicylic acid) organic (e.g. amine and iodine) complexes.
3. Characterisation of complexes by electronic and IR spectral data.
4. Estimation of  $Pb^{2+}$  and  $Cd^{2+}/Zn^{2+}$  and  $Ni^{2+}$  by polarography.
5. To obtain solubility curve for a ternary system of liquids, water-acetic acid, acid - chloroform system.
6. To estimate oxalic acid by carrying out suitable conductometric titration in the following solutions.
  - (i) A solution of pure Oxalic acid.
  - (ii) A solution of Oxalic acid and HCl.
  - (iii) A solution of oxalic acid and  $CH_3COOH$

**(b) Minor**

1. Capacitor as charge storage device
2. To study the behaviour of parallel charged capacitor in series charged Capacitor placed in parallel.
3. The use of LCR bridge
4. Response characteristics of LCR network.
5. Measurement of e.m.f. of thermocouple.
6. To plot characteristics curve of diode.

7. Capacitor filter for full wave rectifier.

**Books suggested**

1. Inorganic Experiments, J. Kerek Woollins, VCH.
2. Microscale Inorganic Chemistry, Z. Sqafran, R.M. Pike and M.M. Singh, Wiley.
3. Practical Inorganic Chemistry, G.Marr and B.W. Rockett, Van Nostrand.
4. The Systematic Identification of Organic Compounds, R.L. Shriner and D.Y. Cutin.
5. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J.B. Entrikin and E.M. Hodnett.
6. Experimental Organic Chemistry. M.P. Doyle and W.S. Mungall.
7. Small Scale Organic Preparations, P.J. Hill.
8. Organometallic Synthesis, J.J. Fisch and R.B. King, Academic.
9. Experimental Physical Chemistry, D.P. Shoemaker, C.W. Garland and J.W. Niber, McGraw Hill, Interscience.
10. Finalay's Practical Physical Chemistry, revised B.P. Levitt, longman.
11. Experiments in Physical Chemistry, J.C. Ghosh, Bharti Bhavan.

**INSTRUCTIONS FOR PRACTICALS****Max Marks: 100****Time: 07 Hours**

The Board of Examiners will constitute of one External Examiner and one Internal Examiner.

**Marks****(A) Inorganic**

Spectrophotometric or Flame Photometric or Chromatographic (one exercise) -15

**(B) Organic**

(a) Multi-step Synthesis or Extraction of organic compound -15  
(b) Spectroscopy or Spectrophotometric estimations -10

**(C) Physical**

1. One experiment is to be performed from major and one from minor  
Major -20  
Minor -05

**(D) Viva**

(E) Record -10

(F) Seminar -15

**PAPER XX-PRACTICALS (FOR GROUP-D)****Time : 07 Hours****Max Marks-100****A. Microscopic and forensic examination (any five)**

1. Microscopical examination of hair: - measurement of medullary index, hair index, scale count etc.
2. Drawing and identification of the skull and other body bones.
3. Determination of height of an individual by the measurements of long bones.
4. Determination of the sex of a person by the examination of bones.
5. Determination of age of the person by the bones.
6. Some anthropological measurements of head length and width. Cephalic

index, measurement of height, measurements of arm span, measurements of upper limbs and lower limbs.

7. Examination of blood sample; Preliminary colour test, crystal test and species determination and Blood Group.
8. Laboratory examination of semen stain; preliminary test, crystal sperm identification and its staining, acid phosphate test
9. Laboratory examination of urine stain.
10. Laboratory examination of saliva stain.
11. Forensic examination of hair: - measurement of medullary index hair, index, scale count.
12. Forensic examination of some fibers:- microscopical & Chemical tests.
13. Comparison of tool marks by comparison microscope.
14. Spottings of forensic specimens

#### B. Qualitative Analysis (Any five)

1. Identification of some ink by paper chromatography and TLC.
2. Identification of some insecticides and pesticides by TLC.
3. Identification of some barbiturates by TLC
4. Identification of amino acids, Sugars, drugs by paper chromatography and TLC.
5. Identification of pesticides, vegetable poisons from bio-specimen by Spot test.
6. Identification of pesticides, opium and morphine.
7. Identification of ganja.
8. Colour reactions of amino acids – qualitative analysis of amino acid.
9. Qualitative Analysis of compounds containing purine group.
10. Qualitative Analysis of alkaloids.
11. Qualitative Analysis of Alkaloids.
12. Preparation of Lactose from milk.
13. Preparation of Casein from milk.
14. Preparation of Caffeine from tea leaves.
15. Preparation of cystine from human hair.
16. Preparation of D(+) glucose from cane sugar.
17. Preparation of Hippuric acid from urine.

#### C. Quantitative Analysis (Any five)

1. Determination of concentration of liquid by spectrophotometer.
2. Determination of pH of given acid/base/buffer.
3. Estimation of morphine by spectrophotometer.
4. Estimation of methyl alcohol by spectrophotometer.
5. Wavelength calibration of UV-VIS Spectrophotometer.
6. Spectrophotometric determination of cobalt-UV-VIS spectrophotometer/ spectronic 20.
7. Estimation of total reducing sugars in molasses.
8. Qualitative analysis of opium and the estimation of morphine content.
9. Qualitative estimation of carbohydrates, proteins, non-protein nitrogen, lipids, etc.
10. Estimation of lead in blood and urine by dithiozone methods.

11. Estimation of copper in viscera
12. Estimation of As, Hg (macro and micro methods).
13. Determination of blood alcohol by various methods.
14. Assay of chloral hydrate.
15. Spectrometric estimation of glucose, urea, creatinine and cholesterol
16. Use of pH meter-preparation of buffer of forensic biochemical relevance.
17. Estimation of glucose.
18. Estimation of glycine.
19. Determination of Acid Value of polymer.
20. Determination of Iodine Value of polymer.
21. Determination of Rancidity of oil sample.

#### (D) Separation and identification (any five)

1. Separation and identification of volatile organic solvent from the mixture of liquids by distillation method.
2. Separation and identification of non-volatile organic solvents from urine sample. Solvents: methyl alcohol, ethyl alcohol, chloroform, diethyl ether, carbon tetra chloride, acetone, benzene etc.
3. Separation and estimation of a mixture containing ethanol, methanol and isopropanol using gas chromatography.
4. Qualitative analysis of opium and the estimation of morphine content.
5. Qualitative and quantitative analysis of ganja.

#### (E) Identification of metallic poisons and anions

1. Separation and identification of acidic and neutral volatile poisons from urine sample by steam distillation. Volatile poisons: chloral hydrate, phenol.
2. Separation and identification of some basic volatile poisons from urine sample by steam distillation method. E.g. amphetamine, nicotine, ephedrine etc.
3. Identification of some metallic poisons by colour/spot/crystal/tests As, Sb, Cu, Ag, Pb, Hg, Fe, Co, Ni, Cr, Cd etc.
4. Identification of some anions by colour/chemical tests; sulphate, sulphide, nitrate, nitrite, carbonate, chloride, bromide, iodide, etc.
5. Separation, purification and identification of compounds of ternary mixtures (three solids) using chemical tests.

#### INSTRUCTIONS FOR PRACTICALS

Max Marks: 100

Time: 07 Hours

The Board of Examiners will constitute of one External Examiner and one Internal Examiner.

#### Marks

(A) Microscopic and Forensic Examination (one exercise)	-20
(B) Qualitative Analysis (one exercise)	-10
(C) Quantitative Analysis (one exercise)	-15
(D) Separation and Identification (one exercise)	-10
(E) Identification of metallic poisons and anions (one exercise)	-10
(F) Viva	-10
(G) Record	-10
(H) Seminar	-15

#### BOOKS SUGGESTED FOR GROUP "D"

1. VK Sharma Instrumental Methods of Chemical Analysis.
2. Skoog Principles of Instrumental Analysis.
3. Ewing Instrumental Methods of Chemical Analysis.
4. HE Thomas Hand Book of Pharmaceutical and Clinical Measurements and Analysis.
5. GH Morrison Trace Analysis-Physical Methods.
6. Krishnan An Introduction to Modern Criminal Investigation.
7. Willard, Merrit & Dean Instrumental methods of Analysis.
8. BK Sharma Instrumental Methods of Chemical Analysis.
9. S.N. Tiwari Monograph on Toxicology.
10. Sharma JD Vidhi Vigyan and Vish Vigyan
11. Remington Text Book of pharmaceutical Science
12. Clark Toxicology
13. Welcher Standard Methods of Chemical Analysis.
14. Gliaster Medical Jurisprudence and Toxicology.
15. Curry Forensic Science Vol. 4
16. Keith Simpson & Bernard Forensic Medicine.
17. Alan Curry Poison detection in Human Organ.
18. OP Agarwal Chemistry of Organic Natural Products Vol. I and II.
19. Hawk Physiological Chemistry.
20. Morrison and Boyd Organic Chemistry.
21. SN Tiwari Manual on Toxicological Analysis.
22. Culliford Manual on Examination of Blood Stains
23. Stryer Bio-Chemistry.
24. Taylor Medical Jurisprudence.
25. Parikh Chikitsa Nyaya Shastra Aur Vish Vigyan (Hindi)
26. C.C. Chaterji Human Physiology.
27. Ross & Wilson Foundations of Anatomy and Physiology.
28. Krogmaman The Human Skeleton in Forensic Medicine.
29. Surandernath An Introduction to Forensic Anthropology.
30. Tedeschi, etc. Forensic Medicine. Vol. I, II, III
31. Nandi Forensic Medicine.
32. EJ Gardner, MJ Simmons Principles of Genetics (John Wiley, New York).
33. Thaddeus Mann The Biochemistry of Semen and of the Male Reproductive Tract (Methuen & Co. Ltd. London).
34. PL Williams & R. Warwick Gray's anatomy (Chrchill Livingstone, London).
35. Metropolitan Police Forensic Science Laboratory, London: Biology Methods Manual.
36. N.G. Dey & T.K. Dey Medical bacteriology (Allied Agency, Calcutta).
37. Brain Lane The Encyclopedia of forensic science (Headline, London.)
38. Richard Safestein Criminalistics: An introduction to forensic science (5<sup>th</sup> Edn. Prentice Hall, Englewood Cliffs, New Jersey)
39. CEO' Hara and GLO' Hara Fundamental of criminal investigation (6<sup>th</sup> Edn. Charles C Thomas. Springfield, Illinois)

40. BS Nabar Forensic Science (SVP National Police Academy Hyderabad).
41. R. Safferstein Forensic Science Hand book Vol. I, II, & III (Prentice Hall, Englewood Cliffs, New Jersey)
42. A.S. Curry Methods of forensic science Vol. III (Interscience Publisher, London)
43. CGG Aitken and The use of statistics in forensic science (Ellis D.A. Stoney Horwood Ltd. New York)
44. B.R. Sharma Forensic Science in Criminal investigation and trials (Central Law Agency, Allahabad)
45. L Zechmeister and L Cholnoky Principles and practices of chromatography (Chapman & Hall, London).
46. R E Dodd Chemical Spectroscopy (Elsevier, Amsterdam).
47. Willard, H Hobart et al Instrumental methods of Analysis (CBS Publishers, Delhi).
48. Wischnitzer, Saul Introduction to Electron Microscopy (Pergamon Press, New York).
49. GH Jeffery, et al Vogel's Textbook of Quantitative Chemical Analysis (5<sup>th</sup> Edn. Wesley Longman, Singapore).
50. Christian, d Gray and Atomic Absorption Spectroscopy (Wiley Feldman Interscience, New York)
51. A.B. Littlewood Gas Chromatography: Principles, Techniques and Applications (Academic Press, New York)
52. Welcher., J. Frank Standard Methods of chemical analysis (6<sup>th</sup> Edn. Vol. 3, Part A. Robert E Krieger Publishing Co., New York).
53. G. Chatwal & S. Anand Instrumental Methods of Chemical Analysis (Himalaya Publishing House, Bombay)
54. Lawes, Grahame Microscopy and X-Ray
55. Ewing, Glalenwood Analytical Instrumentation Hand Book, 2<sup>nd</sup> rev. Ed. (Marcel dekker, New York).
56. Genel, L Barbra Biological Electron Microscopy (Van Nostrand Reinhold Co., New York)
57. Reimer and Ludwig Scanning Electron Microscopy: Physics of image formation and microanalysis (Springer-veriag-Berlin)
58. Frank M Biffen and Modern Instruments in Chemical Analysis (Mc William Seaman Graw Hill, New York)
59. Gerald W. King Spectroscopy and Molecular Structure (Holt Rime Hart and Winston, New York)
60. K Kackschalger Errors, Measurements & Result in Chemical Analysis (Van, Nostrand Reinhold, London).
61. J. Bassett, et al Vogel's Text Book of Quantitative Inorganic Analysis (4<sup>th</sup> Edn. Longmans Essex).
62. Iras Lurie and High Performance Liquid Chromatography in John D Wittor Jr. Forensic Chemistry.
63. GL Gooberman Ultrasonics-Theory and applications (English University Press, London)
64. David M. Mercules Fluorescence and Phosphorescence Analysis

65. H. Ward Smith Principle and Applications (Interscience Publishers, New York)  
Methods of determining alcohol in methods of forensic science Vol. IV (Interscience Publishers New York).
66. I C Garret The quantitative analysis of drugs (Chapman and Hall)
67. FD Smell & FD Biffen Commercial methods of analysis 2<sup>nd</sup> Edn. (Chemical Pub. Co. Lnc.)
68. John Steward The Paint-Laboratory Note Book (Leonard Hill Remington Ltd.
69. R.S. Drago Physical methods of inorganic chemistry (Reinhold Pub.)
70. D.G. Peters et al Chemical Separation and measurements (Sauders Co.)
71. G.W. Himus Fuel Testing (Leonard Hill).
72. F. Fiegl and V Anger Spot Tests in Organic Analysis (Elsevier, Amsterdam).
73. F. Fiegl and V Anger Spot Tests in Organic Analysis (Elsevier, Amsterdam).
74. Snell & Snell Colorimetric Method of Analysis (Van Nortland)
75. N.D. Cheronis et al Identification of organic compounds using semi micro techniques (Wiley).
76. Erich Leschle Clinical Toxicology (J.A. Churchill, London)
77. C.J. Polson and Clinical Toxicology (English University Press, R. Tattesall London)
78. A. Looms Essentials of Toxicology (Less & Febiger, Philadelphia)
79. William H Warren Laboratory manual for the detection of poisons and powerful drugs (P Blakiston's Son & Co. Philadelphia).
80. C.P. Stewart Toxicology-Mechanisms and Analytical and Stolman Methods Vol. I & II (Academic Press, New York)
81. Franck Bamford Poisons - Their Isolation and Identification (J.A. Churchill, London).
82. Irving Sunshine et al Guideline for Analytical Toxicology Programs Vol. I (CRC Press)
83. Alan Curry Poison Detection in Human Organs (Charles C Thomas)
84. F. Lundgäst et al Methods in Forensic Science (Vo. I to IV. Interscience Publishers, New York).
85. A Stolman Progress in Chemical Toxicology Vol. I, II (Academic Press, New York)
86. M.J. Pelezar, EC S Reid Microbiology V Edn. (Tata Mc Graw Hill Publishing & Chan Co., New Delhi).
87. Stites D.P et al Basic & Clinical Immunology 5<sup>th</sup> Edn. (Lange Medical Publications, Losatios)