

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS**  
**COLLEGE, RAJNANDGAON (C.G.)**



**M.Sc. Chemistry**

**First Semester**

**2024-25**

## Syllabus and Marking Scheme for First Semester

**Session 2024-25**

Paper No.	Title of the Paper	Marks Allotted in Theory		Marks Allotted in Internal Assessment		Credits
		Max	Min	Max.	Min.	
I	CO-ORDINATION CHEMISTRY	80	16	20	04	04
II	BASICS OF ORGANIC CHEMISTRY AND REACTION MECHANISM	80	16	20	04	04
III	MATHEMATICS FOR CHEMISTS, QUANTUM CHEMISTRY AND CHEMICAL DYNAMICS	80	16	20	04	04
IV	GROUP THEORY, PRINCIPLES OF SPECTROSCOPY AND COMPUTER FOR CHEMISTS	80	16	20	04	04
V	Lab Course I PHYSICAL CHEMISTRY PRACTICAL	100	36	---	---	02
IV	Lab Course II INORGANIC CHEMISTRY PRACTICAL	100	36	---	---	02
	<b>Total</b>	<b>520</b>	<b>---</b>	<b>80</b>	<b>---</b>	<b>20</b>

04 Theory papers	-	320
04 Internal Assessments	-	80
02 Practical	-	200
<b>Total Marks</b>	-	<b>600</b>

**Note:** 25 marks = 01 credit in Theory Papers and 50 Marks = 01 Credit in Practical.

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**

**SEMESTER - I**

**2024-25**

**PAPER- I**

**CO-ORDINATION CHEMISTRY**

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**Max. Marks: 80**

**Min. Marks : 16**

- Unit - I      Theories of Chemical Bonding in Co-ordination Chemistry**  
Basic knowledge of VBT, CFT, VSEPR, Walsh diagrams (tri- and penta-atomic molecules),  $d\pi - p\pi$  bonds, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.  
Jahn-Teller distortion, causes of distortion  
**Metal  $\pi$ -Ligand Bonding**  
Limitation of and applications of valence bond theory, crystal field theory, ligand field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes,  $\pi$ - bonding and molecular orbital theory.
- Unit -II      Metal  $\pi$ -Complexes**  
 $\pi$ -acceptor ligands,  $18 e^-$  rule, Hapticity, Sandwich compounds, Preparation and chemical properties of 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.
- Unit -III      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. Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories.

**Unit –IV Reaction Mechanism of Transition Metal Complexes**

Kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reaction, cross reactions and Marcus-Hush theory, inner sphere type reactions.

**LIST OF REFERENCE BOOKS:**

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. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
5. Magnetochemistry, R.L. Carlim, Springer Verlag.
6. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.
7. Modern spectroscopy, J. M. Hollas, John Wiley.
8. Applied electron spectroscopy for chemical analysis Ed. H. Windawi and F.L. Ho, Wiley Interscience.
9. Mechanisms of Inorganic Reactions, Fred Basalo and Ralph G. Pearson, Wiley Eastern Private Lt

		Departmental members	
Chairperson /H.O.D .....		1.....	8.....
Subject Expert .....	<u>A. B. Maurya</u>	2.....	9.....
(University Nominee)	<u>A. Asthara</u>	3.....	10.....
Subject Expert .....	<u>Dr. A.K. Jha</u>	4.....	11.....
Representative .....		5.....	12.....
(Industry)		6.....	13.....
Representative .....		7.....	14.....
(Alumni)			
Representative .....			
(Professor Science Faculty Other Dept.)			

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**  
**SEMESTER-I**

2024-25

**PAPER- II**

**BASICS OF ORGANIC CHEMISTRY, STEREOCHEMISTRY &  
REACTION MECHANISM**

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**Max. Marks : 80**

**Min. Marks : 16**

**Unit -I: Fundamental concepts of organic reactions**

Electronic effects in organic molecules; inductive effective, electrometric effect, hyperconjugation, resonance, mesomeric/resonating effect, tautomerism, Conjugation in organic compounds, bonding in Fullerenes, bonds weaker than covalent, addition compounds.

**Stereochemistry**

Elements of symmetry, chirality, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis using chiral reagent, chiral catalysts, chiral auxiliary and chiral substrates (*Felkin-Anh* model and *Cram's* rule), 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.

**Conformational analysis**

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

**Unit-II: Reaction Intermediates**

Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes, nitrenes, benzyne and ylides

**Reaction Mechanism: Structure and Reactivity**

Types of organic reactions, kinetic and thermodynamic control reactions and stability, Effect of structure on reactivity- resonance, steric effects and quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants ( $\sigma$  constant).

**Unit - III: Addition to carbon – carbon multiple bonds**

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regioselectivity and chemoselectivity, orientation and reactivity. Hydrogenation of aromatic rings, hydrogenation of double and triple bonds, markonikov and anti-markonikov rules.

**Addition to Carbon-Hetero multiple bonds**

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl

compounds. Acids, esters and nitriles. Addition of Grignard reagent, organo zinc and organo-lithium reagents to carbonyl and unsaturated carbonyl compounds, Wittig reaction. Mechanism of condensation reaction involving enolates – Claisen, Mannich, Benzoin, Perkin and Stobbe reactions.

#### Unit-IV

##### **Substitution reactions**

##### **Aliphatic Nucleophilic Substitution**

The  $S_N1$ ,  $S_N2$ , mixed  $S_N1$  and  $S_N2$  and SET mechanisms, regioselectivity; retention and inversion of configuration, racemization, the neighboring group mechanism, neighboring group participation by; acetoxy group,  $\pi$  bonds,  $\sigma$  bonds, phenonium ions, norbornyl system, common carbocation rearrangements. The  $S_Ni$  mechanism, Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon, Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium.

##### **Aromatic Nucleophilic substitution**

Addition elimination (Activated complex mechanism) and elimination-addition (benzyne mechanism) reactions, Reactivity- effect of substrate structure, leaving group and attacking nucleophile, The von Richter, Sommelet - Hauser and Smiles rearrangements.

##### **Elimination Reactions**

The E1, E2 and E1cB mechanisms, orientation of the double bond, reactivity -effects of substrate structures, attacking base, the leaving group, temperature, and the medium, mechanism and orientation in pyrolytic elimination (Ei), Elimination versus substitution reaction

#### **LIST OF REFERENCE BOOKS:**

1. Advanced Organic Chemistry – Reaction Mechanism and Structure, Jerry March John Wiley.
2. Handbook of Organic Name Reactions: Reagents, Mechanism and Applications, 1st Edition - August 14, 2023, Authors: Dakeshwar Kumar Verma, Y. Dewangan and CB Verma, ISBN: 9780323959483, Elsevier, Netherland
3. Structure and Mechanism in Organic Chemistry, C.K.Ingold, Cornell University Press.
4. Organic Chemistry, R.T .Morrison and R.N. Boyd, Prentic Hall.
5. Modern organic Reactions. H.O. House Benjamin
6. Principles of Organic Synthesis, R.O.C. Normon and J.M. Coxon, Blackie, Academic & Professional.
7. Organic Reactions and their mechanism, S. Kalsi, New Age International.
8. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan
9. Stereo Chemistry of Organic Compounds, D. Nasipuri, New Age International.

		Departmental members	
Chairperson /H.O.D	<i>[Signature]</i>	1.....	8..... <i>[Signature]</i>
Subject Expert (University Nominee)	<i>AS Khan</i> <i>25/5/2024</i>	2.....	9.....
Subject Expert	<i>[Signature]</i> <i>AK Jha</i> <i>25/05/24</i>	3.....	10.....
Representative (Industry)		4..... <i>[Signature]</i>	11.....
Representative (Alumni)	<i>Libha</i>	5..... <i>[Signature]</i>	12.....
Representative (Professor Science Faculty Other Dept.)		6..... <i>[Signature]</i>	13.....
		7.....	14.....

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**

**SEMESTER- I**

**2024-25**

**PAPER- III**

**MATHEMATICS FOR CHEMISTS, QUANTUM CHEMISTRY**  
**AND CHEMICAL DYNAMICS**

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**Max. Marks: 80**

**Min. Marks : 16**

- Unit-I**      **Vectors, Matrix Algebra and Probability**  
Vectors , dot, cross and triple products etc. The gradient, divergence and curl. Addition and multiplication, inverse, adjoint and transpose of matrices, special matrices (symmetric, Skew-symmetric, Hermitian, Skew- Hermitian, unit, diagonal, unitary, etc) and their properties. Introduction to determinants, Permutations and combinations and probability.
- Differentiation and Integration**  
Rules for differentiation, applications of differential calculus including maxima and minima partial differentiation. Exact first-order differential equations, homogeneous, exact and linear equations, Basic rules for integration, integration by algebraic simplification, integration by parts, partial fraction and substitution.
- Unit-II**      **Quantum Chemistry**  
Time-independent Schrodinger equation and the postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz. particle in one dimensional and three dimensional box, concept of degeneracy, the harmonic oscillator, the rigid rotor, the hydrogen atom.
- Angular Momentum**  
Ordinary angular momentum, eigen functions and eigen values of angular momentum, ladder operator, concept of spin, antisymmetry and Pauli's exclusion principle.
- Unit-III**     **Approximate Methods**  
The variation theorem and perturbation theory (first order and non degenerate). Applications of variation method and perturbation theory to hydrogen and helium atom.
- Electronic Structure of Atoms**  
Russell-Saunders terms and coupling schemes. Atomic states, atomic terms and term symbols.
- Molecular Orbital Theory**  
Huckel theory of conjugated systems, Applications to ethylene, butadiene and cyclobutadiene.



**Unit – IV Chemical Dynamics**

Method of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory, ionic reaction, kinetic salt effects, steady state kinetics. Photochemical reaction (hydrogen-bromine and hydrogen-chlorine reactions). Homogeneous catalysis, kinetics of enzyme reaction, general features of fast reaction, study of fast reaction by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method.

Dynamics of unimolecular reaction, Lindmann-Hinshelwood and Rice- Ramsperger-Kassel-Marcus (RRKM) theories of unimolecular reaction.

**LIST OF REFERENCE BOOKS:**

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. Coulsons Valence R. Mc. Weeny, ELBS
5. Chemical Kinetics, K.J. Laidler, McGraw-Hill
6. Kinetics and Mechanism of Chemical Transformation, J. Rajaraman and J. Kuriacose, McMillan.
7. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
8. Mathematics for Chemists, Bhupendra Singh

Departmental members		
Chairperson /H.O.D ..... 25/6/22		
Subject Expert ..... A. R. K. S. Rao (University Nominee)	1.....	8.....
Subject Expert ..... A. K. S. Rao	2.....	9.....
Representative ..... (Industry)	3.....	10.....
Representative ..... N. B. K. Rao (Alumni)	4.....	11.....
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**DEPARTMENT OF CHEMISTRY**  
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**M.Sc. CHEMISTRY**

**SEMESTER - I**

**2024-25**

**PAPER- IV**

**GROUP THEORY, PRINCIPLES OF SPECTROSCOPY AND COMPUTER  
FOR CHEMISTS**

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**Max. Marks : 80**

**Min. Marks : 16**

- Unit I      Symmetry and Group Theory in Chemistry**  
Symmetry elements and symmetry operation, definition of group, subgroup, relation between order of a finite group and its subgroup. Conjugacy relation and classes. point symmetry group. Schonflies symbols, representations of groups by matrices (representation for the  $C_n$ ,  $C_{nv}$ ,  $C_{nh}$ ,  $D_{nh}$  etc. groups to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their uses in spectroscopy.
- Unit –II    Unifying Principles**  
Electromagnetic radiation, interaction of electromagnetic radiation with matter absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation and natural line width and natural line broadening, transition probability, results of the time dependent perturbation theory, transmission moment, selection rules, intensity of spectral lines. Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels.
- Unit –III   Introduction to Computers and Computing**  
Basic structure and functioning of computers with a PC as an illustrative example. OS with DOS as an example, Introduction to UNIX and WINDOWS data processing, principals of programming, Algorithms and flow- charts. Elements of computer language C, Constant and variables, Operations and symbols,, Expression, Arithmetic assignment statements.

**Unit – IV Atomic Absorption Spectroscopy**

Principle and instrumentation, flame atomization, hollow cathode lamps, interference in AAS, applications of AAS in qualitative and quantitative analysis. The Techniques of Atomic Absorption Spectrometry, The Individual Elements for Arsenic (As), Cadmium (Cd), Calcium (Ca), Magnesium (Mg), Manganese (Mn), Iron (Fe), Lead (Pb), Zinc (Zn).

**Flame photometric methods:** Basic principle and instrumentation, interference in flame photometry, applications in quantitative analysis.

**Nephelometric method:** Principle and instrumentation, applications in analysis

**LIST OF REFERENCE BOOKS:**

1. Computers and Common Sense, R. Hunt and J. Shelley, Prentice Hall.
2. Computers Chemistry, A.C. Norris.
3. Microcomputer Quantum Mechanics, Killingbeck, Adam Hilger.
4. Computer Programing in Fortran IV, V. Rajaraman, Prentice Hall.
5. An Introduction to Digital Computer Design, V. Rajaraman and T. Radhakrishnan, Prentice Hall.
6. Physical Methods in Chemistry, R.S. Drago, Saunders College.
7. Chemical Applications of Group Theory, F.A. Cotton.
8. Group Theory and its Chemical Applications, P.K. Bhattacharya, Himalya Publishing House.
9. Instrumental Methods of Analysis, B.K. Sharma, Krishna Publication.
10. Atomic Absorption Spectrometry, Bernhard Welz, Michael Sperling, WILEY-VCH.

		Departmental members	
Chairperson /H.O.D			
Subject Expert (University Nominee)	 25/5/2022	1.....	8.....
Subject Expert	 ASJho	2.....	9.....
Representative (Industry)		3.....	10.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. Chemistry**  
**[First Semester]**  
**Laboratory Course I**  
**Physical Chemistry & Computers Practical**  
**2024-25**

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**Max. Marks : 100**

**Number of hours for each experiment: 3-4 hours**

A list of experiments under different headings is given below. Typical experiments are to be selected from each type.

**MAJOR EXPERIMENTS**

**Adsorption**

1. To study surface tension – concentration relationship for solution (Gibb's equation).
2. To study the adsorption of oxalic acid on charcoal and to verify Freundlich adsorption isotherm.

**Chemical Kinetics**

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 the rate constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as an iodine clock reaction.

**Polarimetry**

1. Determine the specific and molecular rotation of optically active substance.
2. Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.

**MINOR EXPERIMENTS**

**Phase Equilibria**

1. Determination of congruent composition and temperature of a binary system (e.g. diphenylamine-benzophenone system.)
2. Determination of glass transition temperature of a given salt (e.g.,  $\text{CaCl}_2$ )

3. To construct the phase diagram for three component system (e.g., chloroform – acetic acid- water).

#### **Solutions**

1. Determination of molecular weight of non-electrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte.
2. Determination of molecular weight of non-volatile substances by Landsberger's method.

#### **Conductometry**

1. To determine the basicity of an organic acid.
2. Determination of solubility and solubility product of sparingly soluble salts (e.g.  $\text{PbSO}_4$ ,  $\text{BaSO}_4$ ) conductometrically.
3. Determination of the strength of strong and weak acids in a given mixture conductometrically.
4. Determination of  $\text{pK}_a$  of acetic acid and verification of Ostwald Dilution law

#### **Potentiometry/pH metry**

1. Determination of the strength of strong and weak acids in a given mixture using a potentiometer /pH meter.
2. Determination of temperature dependence of EMF of a cell.
3. To determine  $\text{pK}_a$  of the given monobasic acid by pHmetric titration.
4. Determination of the dissociation constant of monobasic/dibasic acid by Albert-Serjeant method.

#### **Use of Computer Programs**

The students will learn how to operate a PC and how to run standard Programs with data preferably from physical Chemistry laboratory. Further, the student will operate Word Processing software such as MS-WORD, MS-Excel, MS-Powerpoint. Introduction to structure drawing, spread sheet and chemistry related softwares chem draw, chem sketch, origin pro.

#### **LIST OF REFERENCE BOOKS:**

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.Plevitt, Longman.
3. Experimental Physical Chemistry ,R.C.Das and B. Behra, Tata McGraw Hill.

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. Chemistry**  
**[First Semester]**  
**Laboratory Course II**  
**Inorganic Chemistry**  
**2024-25**

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**Max. Marks : 100**

**MAJOR EXPERIMENTS**

**Qualitative analysis**

Qualitative analysis of mixture containing eight radicals including two less common metals from among the following by semi micro method.

**Basic Radicals :**

Ag, Pb, Hg, Bi, Cu, Cd, As, Sb, Sn, Fe, Al, Cr, Zn, Mn, Co, Ni, Ba, Sr, Ca, Mg, Na, K,  
Ce, Th, Zr, W, Te, Ti, Mo, U, V, Be, Li, Au, Pt.

**Acidic Radicals :**

Carbonate, Sulphite, Sulphide, Nitrite, Nitrate, Acetate, Fluoride, Chloride,  
Bromide, Iodide, Sulphate, Borate, Oxalate, Phosphate, Silicate, Thiosulphate,  
Ferricyanide, Sulphocyanide, Chromate, Arsenate and Permanganate.

**Quantitative Analysis**

Separation and determination of two metal ions in ores, alloys, or mixtures in solution, one by volumetric and the other by gravimetric methods.

**MINOR EXPERIMENTS**

**Estimations**

- (a) Phosphoric acid in commercial orthophosphoric acid.
- (b) Boric acid in borax.
- (c) Ammonia in an ammonium salt.
- (d) Manganese dioxide in pyrolusite.
- (e) Available chlorine in bleaching powder.
- (f) Hydrogen peroxide in a commercial sample.

### Preparations

Preparation of selected inorganic compounds and their study by I.R. Electronic spectra, Mossbauer, E.S.R. and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds. Theoretical study of structure and their identification of some preparations by spectral analysis

- |  |  |
|--|--|
| 1. VO (acac) <sub>2</sub>  | 2. TiO (C <sub>9</sub> H <sub>8</sub> NO) <sub>2</sub> ·2H <sub>2</sub> O    |
| 3. Cis-K [Cr (C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub> (H <sub>2</sub> O) <sub>2</sub> ] | 4. Na[Cr(NH <sub>3</sub> ) <sub>2</sub> (SCN) <sub>4</sub> ]                 |
| 5. Mn (acac) <sub>3</sub>  | 6. K <sub>3</sub> [Fe (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> ]        |
| 7. Prussian Blue, Turnbull's Blue.   | 8. [Co (NH <sub>3</sub> ) <sub>6</sub> ][Co(NO <sub>2</sub> ) <sub>6</sub> ] |
| 9. Cis-[Co(trien)(NO <sub>2</sub> ) <sub>2</sub> ]Cl·H <sub>2</sub> O                        | 10. Hg[Co(SCN) <sub>4</sub> ]  |
| 11. [Co(Py) <sub>2</sub> Cl <sub>2</sub> ]   | 12. [Ni(NH <sub>3</sub> ) <sub>6</sub> ]Cl <sub>2</sub>                      |
| 13. Ni(DMG) <sub>2</sub>   | 14. [Cu(NH <sub>3</sub> ) <sub>4</sub> ]SO <sub>4</sub> ·H <sub>2</sub> O    |

### LIST OF REFERENCE BOOKS:

1. Vogel's Text Book of Qualitative Analysis, revised, J. Bassett, R.C.Denney, G.H. Jeffery and J. Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W.L.Jolly, Prentice Hall.

		Departmental members	
Chairperson /H.O.D .....		1.....	8.....
Subject Expert ..... (University Nominee)	 25/5/24	2.....	9.....
Subject Expert.....	 25/05/24	3.....	10.....
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		7.....	14.....

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS**  
**COLLEGE, RAJNANDGAON (C.G.)**



**M.Sc. Chemistry**

**Second Semester**

**2024-25**



**Syllabus and Marking Scheme for Second Semester**

**Session 2024-25**

Paper No.	Title of the Paper	Marks Allotted in Theory		Marks Allotted in Internal Assessment		Credits
		Max	Min	Max.	Min.	
I	<b>TRANSITION METAL COMPLEXES AND DIFFRACTION METHODS</b>	80	16	20	04	04
II	<b>BIOMOLECULES AND STEREOCHEMISTRY</b>	80	16	20	04	04
III	<b>THERMODYNAMICS, ELECTROCHEMISTRY AND SURFACE CHEMISTRY</b>	80	16	20	04	04
IV	<b>SPECTROSCOPY</b>	80	16	20	04	04
V	Lab Course I <b>ORGANIC CHEMISTRY PRACTICAL</b>	100	36	----	----	02
IV	Lab Course II <b>ANALYTICAL CHEMISTRY &amp; COMPUTER PRACTICAL</b>	100	36	----	----	02
	<b>Total</b>	<b>520</b>	<b>---</b>	<b>80</b>	<b>---</b>	<b>20</b>

**04 Theory papers - 320**

**04 Internal Assessment - 80**

**02 Practical - 200**

**Total Marks - 600**

**Note: 25 marks = 01 credit in Theory Papers and 50 Marks = 01 Credit in Practical**

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**

**SEMESTER - II**

**2024-25**

**PAPER- I**

**TRANSITION METAL COMPLEXES AND DIFFRACTION METHODS**

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**Max. Marks : 80**

**Min. Marks : 16**

- Unit-I**      **Electronic Spectra of Transition Metal Complexes**  
Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes ( $d^1$ - $d^9$  states), calculations of  $Dq$ ,  $B$  and parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information.
- Magnetic Properties of Transition Metal Complexes**  
Magnetic properties of octahedral, tetrahedral, tetragonally distorted square planar, trigonal bipyramidal and square bipyramidal complexes based on CFT, spin equilibrium, spin free and spin paired equilibria, quenching of orbital angular momentum by ligand field, Magnetic properties of complexes with A, E and T terms, spin orbit coupling.
- Unit -II:**    **Metal clusters**  
Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds. Wade's rule, styx number, isolobal analogy, applications of boron compounds, synthesis and structures of S-N cyclic compounds
- Unit - III:**    **Lanthanoids and actinoids and Electron Diffraction**  
Introduction, occurrence, physical and chemical properties, electronic spectra and magnetic properties- oxidation states, term symbols, color transition, organometallic compounds and recent applications.
- 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.

**Unit-IV X-Ray Diffraction**

Bragg condition, Miller indices, Laue method, Bragg method, Debye – Scherrer method of X-Ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern. Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity and electron density, phase problem. Ramchandran Diagram.

**Neutron Diffraction**

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

**LIST OF REFERENCE BOOKS:**

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huheey, Harpes & Row.
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
5. Magnetochemistry, R.L. Carlin, Springer Verlag.
6. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.
7. Modern spectroscopy, J. M. Hollas, John Wiley.
8. Applied electron spectroscopy for chemical analysis Ed. H. Windawi and F.L. Ho, Wiley Inter science.

		Departmental members	
Chairperson /H.O.D			
Subject Expert (University Nominee)		1.....	8.....
Subject Expert		2.....	9.....
Representative (Industry)		3.....	10.....
Representative (Alumni)		4.....	11.....
Representative (Professor Science Faculty Other Dept.)		5.....	12.....
		6.....	13.....
		7.....	14.....

DEPARTMENT OF CHEMISTRY  
GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON  
M.Sc. CHEMISTRY

SEMESTER - II

2024-25

PAPER- II

REACTION MECHANISM, REARRANGEMENTS AND REAGENTS

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Max. Marks : 80

Min. Marks : 16

**Unit I: Substitution Reactions**

**Aliphatic Electrophilic substitution**

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

**Aromatic Electrophilic substitution**

The arenium ion mechanism and important Electrophilic substitution reactions, directing effect, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, diazonium coupling.

**Aromaticity**

Aromaticity in homocyclic and heterocyclic compounds Huckel's rule, anti-aromaticity, homo-aromaticity, non-aromaticity, quasi aromatic compounds PMO approach for Aromaticity and Annulenes.

**Unit II: Free Radical Reactions**

Types of free radical reactions, free radical substitution mechanism at an Aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compound by diazonium salts, Sandmeyer reaction. Free radical rearrangement, Hunsdiecker reaction

**Unit -III: Pericyclic Reactions**

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffman correlation diagrams. FMO and PMO approach. Electrocyclic reactions- conrotatory and disrotatory motions,  $4n$ ,  $4n+2$  and allyl systems. Cycloadditions- antarafacial and suprafacial additions,  $4n$  and  $4n+2$  systems,  $2+2$  addition of ketenes. Sigmatropic rearrangements, suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties,  $3, 3$ - and  $5,5$ - sigmatropic rearrangements. Claisen, Cope and aza-

Cope rearrangements.

**Unit –IV    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, Neber, Beckmann, Hofman, Curtius, Schmidt, Baeyer-villiger, Shapiro reaction.

**Reagents**

**Oxidation-** Oxidation of hydrocarbons, Oxidation of alcohols, Oxidation of aldehydes and ketones

**Reduction-** Catalytic hydrogenation, Reduction by dissolving metals, Reduction by hydride-transfer reagents

**List of Reference Books**

1. Advanced Organic Chemistry – Reaction Mechanism and Structure, Jerry March John Wiley.
2. Handbook of Organic named reactions: Reagents, Mechanisms and Applications, Dakeshwar Kumar Verma, Y Dewangan and CB Verma, ELSEVIER, Netherland, 2023.
3. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.
4. Organic Chemistry, R. T. Morrison and R.N.Boyd, Prentice Hall.
5. Modern Organic Reactions. H.O. House Benjamin
6. Principles of Organic Synthesis, R.O.C. Normon and J.M. Coxon, Blackie, Academic &professional.
7. Pericyclic reactions, S.M. Mukherji, Macmillan India.
8. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan
9. Stereo Chemistry of Organic Compounds, D. Nasipuri, New Age International.
10. Stereo Chemistry of Organic Compounds, P.S. Kalsi, New Age International.
11. Organic Chemistry, I.L.Finar, Vol. I & II, EL
12. Advanced Organic Chemistry – Reaction Mechanism and Structure, Jerry March John Wiley.
13. Advanced Organic Chemistry, F.A. Carey and R.J. Sundbery, Plenum
14. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.
15. Organic Chemistry, R. T. Morrison and R.N.Boyd, Prentice Hall.
16. Modern Organic Reactions. H.O. House Benjamin Principles of Organic Synthesis, R.O.C. Normon and J.M. Coxon, Blackie, Academic &professional.
17. Pericyclic reactions, S.M. Mukherji, Macmillan India .
18. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan
19. Stereo Chemistry of Organic Compounds, D. Nasipuri, New Age International
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**DEPARTMENT OF CHEMISTRY**  
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**M.Sc. CHEMISTRY**

**SEMESTER - II**

**2024-25**

**PAPER- III**

**THERMODYNAMICS, ELECTROCHEMISTRY AND**  
**SURFACE CHEMISTRY**

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**Max. Marks : 80**

**Min. Marks : 16**

- Unit-I**      **Classical Thermodynamics**  
Brief resume of concept of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significances. Determination of these quantities. Concept of fugacity and determination of fugacity. Non-Ideal system. Excess function for non-ideal solutions, activity, activity coefficient. Debye-Huckel theory for activity coefficient of electrolyte solution, determination of activity and activity coefficients, ionic strength. Application of phase rule to three component systems.
- Unit-II**      **Statistical Thermodynamics**  
Concept of distribution, thermodynamic probability and most probable distribution. Maxwell Boltzmann distribution, Partition functions - translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions. Applications of partitions functions, Fermi-Dirac statistics, Bose-Einstein statistics distribution law.  
**Non-equilibrium Thermodynamics**  
Irreversible thermodynamics, uncompensated heat, first and second law of thermodynamics, entropy production, Onsager equation, coupled reaction.
- Unit - III**      **Electrochemistry**  
Electrochemistry of solution, Debye-Huckel-Onsager treatment and its extension, ion-solvent interaction, Debye-Huckel-Jerum mode. Thermodynamics of electrified interface equation. Derivation of electrocapillarity. Lippmann equation (surface excess) methods of determination of structure of electrified interfaces. Guoy-Chapman, Stern, Graham-Devanathan-Mottwatts, Tobin, Bockris, Devanathan models. Over potentials, Exchange current density, derivation of Butler-Volmer equation, Tafel plot. Semiconductor interfaces theory of double layer at semiconductor, electrolyte solution interface, structure of double layer interfaces, effect of light at semiconductor solution interfaces.

### **Electrocatalysis**

Influence of various parameters. Polarography theory-Ilkovic equation, half wave potential and its significance. Introduction to corrosion, homogeneous theory, forms of corrosion, corrosion monitoring and prevention methods.

## **UNIT -IV Surface Chemistry**

### **Adsorption**

Surface tension, capillary action, pressure difference across curved surface (Laplace equation), Gibbs adsorption isotherm, BET equation and estimation of surface area using BET equation.

### **Micelles**



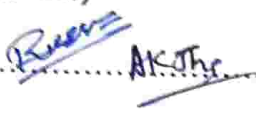

Surface active agents, classification of surface active agents, micellization, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization, reverse micelles.

### **Macromolecules**

**Polymer** : Definition, types of polymers, electrically conducting polymers, mechanism of polymerization, molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion and light scattering methods), sedimentation, chain configuration of macromolecules, calculation of average dimensions of various chain structures.

### **LIST OF REFERENCE BOOKS:**

1. Physical Chemistry, P.W. Atkins, ELBS
2. Thermodynamics, S.Glasstone
3. Statistical Thermodynamics, M.C.Gupta
4. Chemical Thermodynamics, Rastogi & Mishra
5. Kinetics and Mechanism of Chemical Transformation, J. Rajaraman and J. Kuriacose, McMillan
6. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum
7. Modern Electrochemistry Vol.-I and Vol.-II, J.O.M. Bockris and A.K.N.Reddy, Plenum
8. Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanamanand J. Sridhar, Wiley Eastern.

		Departmental members	
Chairperson /H.O.D .....			
Subject Expert ..... (University Nominee)		1.....	8.....
Subject Expert .....		2.....	9.....
Representative ..... (Industry)		3.....	10.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**

**SEMESTER - II**

**2024-25**

**PAPER- IV**

**SPECTROSCOPY**

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**Max. Marks : 80**

**Min. Marks : 16**

- Unit – I    Molecular Spectroscopy**  
Energy levels, molecular orbital, vibronic transitions, vibration progressions 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 complex, charge transfer spectra.  
**Microwave Spectroscopy**  
Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor. Stark effect, nuclear and electron spin interaction and effect of external field. Applications.
- Unit –II    Infrared spectroscopy**  
Review of linear harmonic oscillator, vibrational energy of diatomic molecules, zero point energy, force constant and bond strengths, anharmonicity. Morse potential energy diagram, vibration – rotation Spectroscopy, P, Q, R, branches. Breakdown of Oppenheimer approximation, vibration of polyatomic molecules. Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region, metal ligand vibrations, normal co-ordinate analysis.  
**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 – III    Nuclear Magnetic Resonance Spectroscopy**  
Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, deshielding, spin- spin interactions, factors including coupling constant 'J'. Classification (ABX, AMX, ABC, A<sub>2</sub>B<sub>2</sub>, etc), spin decoupling. Basic ideas about instruments, FT NMR, advantages of FT NMR, use of NMR in medical diagnostics.

### **Nuclear Quadruple Resonance Spectroscopy**

Quadruple nuclei, Quadruple moments, electric field gradient, coupling constant, splitting, applications.

### **Unit –IV Photoelectron Spectroscopy**

Basic principle: photo-electric effect, ionization process, Koopmans theorem, photoelectron spectra of simple molecules, ESCA, chemical information from ESCA.

#### **Photo acoustic Spectroscopy**

Basic principles of photo acoustic spectroscopy (PAS), PAS gases and condensed systems, chemical and surface applications.

#### **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, applications.

### **LIST OF REFERENCE BOOKS:**

1. Modern Spectroscopy J.M. Hollas, Johan Wiley.
2. Applied Electron Spectroscopy for chemical analysis ed. H. Windawi and F.L. Ho, Wiley Interscience.
3. NMR, NQR EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish. Elish Harwood.
4. Physical Methods in Chemistry, R.S. Drago, Saunders Company
5. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
6. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata McGraw- Hill.
7. Application of Spectroscopy of Organic Compounds, J .R. Dyer, Prentice Hall.
8. Organic Spectroscopy, Third Ed., William Kemp, Palgrave Publications.
9. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw- Hill.

		Departmental members	
Chairperson /H.O.D .....		1.....	8.....
Subject Expert ..... (University Nominee)	<u>Abdhi</u>	2.....	9.....
Subject Expert.....	<u>Praveen</u> <u>Alshams</u>	3.....	10.....
Representative ..... (Industry)		4.....	11.....
Representative ..... (Alumni)	<u>Nibha</u>	5.....	12.....
Representative ..... (Professor Science Faculty Other Dept.)		6..... <u>Pradip</u>	13.....
		7.....	14.....

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. Chemistry**  
**[Second Semester]**  
**Laboratory Course I : Organic Chemistry**  
**2024-25**

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**Max. Marks : 100**

**MAJOR EXPERIMENTS**

**Organic Synthesis**

- (i) Acetylation: Acetylation of cholesterol and separation of cholesteryl acetate by column chromatography.
- (ii) Synthesis of  $\beta$ -Naphthyl acetate / Hydroquinone diacetate.
- (iii) Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol
- (iv) Grignard reaction: Synthesis of triphenylmethanol from benzoic acid
- (v) Aldol condensation : Dibenzalacetone from benzaldehyde
- (vi) Sandmeyer reaction : p-chlorotoluene from p-toluidine / o-chlorobenzoic acid from anthranilic acid.
- (vii) Acetoacetic ester Condensation: Synthesis of ethyl-n-butylacetoacetate by A.E.E. condensation.
- (viii) Cannizzaro reaction : 4-chlorobenzaldehyde as substrate / Benzoic acid and benzyl alcohol.
- (ix) Friedel Crafts Reaction:  $\beta$ -Benzoyl propionic acid from succinic anhydride and benzene.
- (x) Aromatic electrophilic substitutions: Synthesis of p-nitroaniline and bromoaniline. The products may be characterized by spectral techniques.

**MINOR EXPERIMENTS**

**Qualitative Analysis**

Separation, purification and identification of compounds of binary mixtures (solid-solid, liquid-solid) using TLC and column chromatography, chemical tests; IR spectra to be used for functional group identification.

**Quantitative Analysis**

- (i) Determination of the percentage of number of hydroxy group in an organic compound by acetylation method.
- (ii) Estimation of amines/phenols using bromated bromide solution /or acetylation method.
- (iii) Estimation of carbonyl group by hydrazone formation method
- (iv) Estimation of Glycine by titration method.
- (v) Determination of equivalent weight of carboxyl compound/ estimation of carboxyl group by titration method/ silver salt method

**LIST OF REFERENCE BOOKS:**

1. Practical Organic Chemistry by A.I. Vogel.
2. Practical Organic Chemistry by Mann and Saunders.
3. Practical Organic Chemistry by Garg and Salija.

		Departmental members	
Chairperson /H.O.D .....	<i>J. S. S. 27</i>		
Subject Expert ..... (University Nominee)	<i>Armi</i>	1.....	8..... <i>Armi</i>
Subject Expert .....	<i>B. S. S. AKTH</i>	2.....	9.....
Representative ..... (Industry)		3..... <i>AKTH</i>	10.....
Representative ..... (Alumni)	<i>Armi</i>	4.....	11.....
Representative ..... (Professor Science Faculty Other Dept.)		5..... <i>AKTH</i>	12.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. Chemistry**  
**[Second Semester]**  
**Laboratory Course II: -Analytical Chemistry**  
**2024-25**

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**Max. Marks : 100**

**MAJOR EXPERIMENTS**

**Analytical Chemistry**

**Error Analysis & Statistical Data Analysis**

Error, types of errors, minimization of errors, statistical treatment for error analysis, standard deviation liner least squares. Calibration of volumetric apparatus, burettes, pipette, standard flask, weight box, etc,

**Volumetric Analysis**

Basic Principle

Determination of iodine and saponification values of oil sample.

Determination of DO, COD, BOD, Hardness of water samples.

**Chromatography**

Separation of cations and anions by

Paper chromatography

Column chromatography

**Flame Photometry / AAS / FIA**

Determination of cations / anions and metal ions e.g.  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{SO}_4^{2-}$ ,  $\text{NO}_2^-$ ,

Fe, Mo, Ni Cu, Zn, etc.

**MINOR EXPERIMENTS**

**Spectrophotometry**

Verification of Beer-Lambert law

Molar absorptivity calculation, plotting graph to obtain  $\lambda_{\text{max}}$  etc.

Effect of pH in aqueous coloured system.


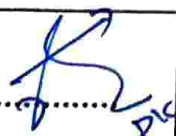


Determination of metal ions e.g. Fe, Cu, Zn, Pb, etc. using inorganic reagent like SCN, an organic chelating agent like dithizone, cupferron, 8-hydroxyquinoline, etc. in aqueous / organic phase in the presence of surface active agents.

**Nephelometry / Turbidimetry**

Determination of chloride, sulphate, phosphate, turbidity, etc.

**LIST OF REFERENCE BOOKS:**

1. Computer for Chemists, Pundhir & Bansal, Pragati Prakashan;
2. Computer and Common Sense, R. Hunt and J. Shelley, Prentice Hall.
2. Computational Chemistry, A.C. Norris.
3. Computer Programming in FORTRAN IV, V. Rajaraman, Prentice Hall
4. B.K Sharma, spectroscopy, Krishna publication

		Departmental members	
Chairperson /H.O.D .....		1.....	8..... 
Subject Expert ..... (University Nominee)	<u>A. Sui</u>	2.....	9.....
Subject Expert.....	<u>AKJF</u> <u>B...</u>	3..... 	10.....
Representative ..... (Industry)		4..... 	11.....
Representative ..... (Alumni)	<u>Vibha</u>	5..... <u>BPL</u>	12.....
Representative ..... (Professor Science Faculty Other Dept.)		6..... <u>Shadm</u>	13.....
		7.....	14.....

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS**  
**COLLEGE, RAJNANDGAON (C.G.)**



**M.Sc. Chemistry**

**Third Semester**

**2024-25**



**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**Scheme for Third Semester**

**Session 2024-25**

Paper No.	Title of the Paper	Marks Allotted in Theory		Marks Allotted in Internal Assessment		Credits
		Max	Min	Max.	Min.	
I	CHROMATOGRAPHIC TECHNIQUES AND APPLICATIONS OF SPECTROSCOPY	80	16	20	04	04
II	BIOCHEMISTRY	80	16	20	04	04
III	ORGANOTRANSITION METAL COMPLEXES	80	16	20	04	04
IV	PHOTOINORGANIC AND ANALYTICAL CHEMISTRY	80	16	20	04	04
V	Lab Course I ANALYTICAL PRACTICAL	100	36	----	----	02
IV	Lab Course II PROJECT	100	36	----	----	02
	<b>Total</b>	<b>520</b>	<b>---</b>	<b>80</b>	<b>---</b>	<b>20</b>

4 Theory papers - 320

04 Internal Assessments - 80

02 Practical - 200

**Total Marks - 600**

**Note: 25 marks = 01 credit in Theory Papers and 50 Marks = 01 Credit in Practical**

DEPARTMENT OF CHEMISTRY  
GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON  
M.Sc. CHEMISTRY

SEMESTER - III

2024-25

Paper - I

CHROMATOGRAPHIC TECHNIQUES AND  
APPLICATIONS OF SPECTROSCOPY

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Max. Marks : 80

Min. Marks : 16

**Unit - I Chromatographic Techniques**

Introduction, classification of chromatographic methods

Basic principles and applications of partition chromatography, paper chromatography, column chromatography, high performance liquid chromatography, thin layer chromatography and gas chromatography.

**Mossbauer Spectroscopy –**

Basic principle spectroscopy parameters and spectrum display, application of the technique to the studies of (i) bonding & structures of  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  compounds including those of intermediate spin detection of oxidation state & inequivalent MB atoms.

**Unit - II Ultraviolet & visible Spectroscopy –**

Various electronic transition (185-800) nm, Beer Lambert law, effect of solvent on electronic transitions ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes conjugated polyenes. Fieser – Woodward's rules for conjugated dienes and carbonyl compounds.

**Vibrational Spectroscopy**

Symmetry and shapes of  $\text{AB}_2$ ,  $\text{AB}_4$  and  $\text{AB}_6$  made of ambidentate Ligand, ethylene diamine and diketonato complex.

**Infrared Spectroscopy –**

Instrumentation & sample handling, characteristic vibrational frequencies of alkanes, aromatic compounds, alcohol, ether, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, acids, lactones and conjugated carbonyl compounds).

Effect of hydrogen bonding and solvent effect on vibrational frequency, overtones, combination bands and Fermi resonance F.T.I.R.

**Unit - III Nuclear Magnetic Resonance Spectroscopy-**

General introduction and Definition , chemical shift , spin-spin interaction , shielding mechanism of measurement , chemical shift value and correlation for protons bonding to carbon .(aliphatic, olefinic, aldehydic & aromatic and other nucleic alcohols, phenols, enols, carboxylic acids amines, amides and mercapto), chemical exchange, effect of deuteration complex, spin-spin interaction between two three (first other spectra) virtual coupling, stereochemistry, hindered rotation, simplification of complex spectra nuclear magnetic double resonance, contact shift reagent solvent effect, fourier transform technique nuclear overhousear effect (NOE), resonance of other nuclei -F, P.

**Nuclear Magnetic Resonance of Paramagnetic Substances in Solution-**  
The contact and pseudo contact shifts, factors affecting nuclear relaxations. Some applications including biochemical systems.

**Unit -IV Carbon-13 NMR Spectroscopy**

General consideration, chemical shift (aliphatic, aromatic, heteroaromatic & carbonyl carbon), coupling constant.

Two dimension NMR spectroscopy – COSY, NOESY.

**Mass Spectroscopy**

Introduction, ion production-EICL, FD and FAB, factors affecting fragmentation, ion analysis ion abundance. Mass spectral fragmentation of organic compounds, common functional group, molecular ion peak, metastable peak. Maclaferty rearrangement, nitrogen rule, High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

**LIST OF REFERENCE BOOKS**

1. Modern Spectroscopy J.M. Hollas , Johan Wiley.
2. Applied Electron Spectroscopy for chemical analysis ed. H. Windawi and F.L. Ho, Wiley Interscience.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry , R.V. Parish, Elish Harwood.
4. Physical Methods in Chemistry , R.S. Drago , Saunders Company.
5. Infrared and Raman Spectra : Inorganic and Coordination Compounds, K. Nakamoto , Wiley.
6. Spectroscopy Methods in Organic Chemistry D.H. Williams , I. Fleming , Tata McGraw-Hill
7. Application of Spectroscopy of Organic Compounds , J.R. Dyer, Prentice Hill.

		Departmental members	
Chairperson /H.O.D .....	<i>[Signature]</i> 22/5/24		
Subject Expert ..... (University Nominee)	<i>[Signature]</i> 25/5/2024	1.....	8..... <i>[Signature]</i>
Subject Expert.....	<i>[Signature]</i> 25/5/24	2.....	9.....
Representative ..... (Industry)		3..... <i>[Signature]</i>	10.....
Representative ..... (Alumni)	<i>[Signature]</i>	4..... <i>[Signature]</i>	11.....
Representative ..... (Professor Science Faculty Other Dept.)		5..... <i>[Signature]</i>	12.....
		6..... <i>[Signature]</i>	13.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**

**SEMESTER - III**

**2024-25**

**PAPER- II**

**BIOCHEMISTRY & BIOMOLECULE**

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**Max. Marks : 80**

**Min. Marks : 16**

**Unit - I      Bioinorganic Chemistry**

**Metal ion in biological system**

Essential and trace metals  $\text{Na}^+/\text{K}^+$  pumps, Role of metal ion in biological process.

**Bioenergetic and ATP cycle**

Metal complexes in transmission of energy, chlorophylls, photosynthesis and photosystem in cleavage of water.

**Electron transfer in Biology**

Electron transport process-cytochromes & iron sulphur proteins.

**Transport and Storage of Dioxygen**

Heme proteins and oxygen uptake, structure and function of Haemoglobin, myoglobin, chemocyanin and chemerythrin, Model synthetic complex of iron, cobalt, copper.

**Nitrogenous base**

Biological nitrogen fixation, molybdenum nitrogenase.

**Unit - II      Bioorganic Chemistry**

**Enzymes**

Chemical & Biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Fisher's lock & key and Koshland's induced fit theory, identification and labeling, Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible & irreversible inhibition.

**Mechanism of Enzyme Action**

Transition state theory, orientation & steric effect, acid - base catalysis. Covalent catalysis, strain or distortion complexes of some typical enzyme, mechanism for lysoenzyme & carboxypeptidase A.

**Co-enzyme Chemistry**

Cofactor as derived from vitamin, coenzyme, prosthetic group apoenzymes, structure and biological function of coenzyme A. Thymine pyrophosphate, pyridoxal phosphate,  $\text{NAD}^+$ ,  $\text{NADP}^+$ , vitamin  $\text{B}_{12}$ .

### Unit - III **Biomolecules**

**Classification of carbohydrates;** Classification based on physical properties, chemical properties, functional groups and reducing nature **Monosaccharides;** Chemistry of D-glucose and D-fructose; Sources and isolation, Reactions of hydroxyl groups, aldehyde groups, Reactions of ketone group, Miscellaneous reactions of glucose, Structural elucidation of glucose, Miscellaneous reactions of D-glucose and D-fructose, Inter-conversions; Aldose to ketose, Ketose to aldose, Aldose to higher aldose, Aldose to lower aldose, Aldose to higher ketose **Disaccharides;** Chemistry of sucrose, Chemistry of lactose, Chemistry of maltose, Chemistry of trehalose **Polysaccharides;** Chemistry of starch, Chemistry of cellulose, Chemistry of glycogen, Chemistry of chitin **Peptides, Proteins and Nucleic Acid:** Chemical and enzymatic hydrolysis of proteins to peptides, secondary structure of proteins, forces responsible for holding of secondary structure. Tertiary structure of proteins folding and domain structure, quaternary structure. Amino acid metabolism, degradation and biosynthesis of amino acids, sequence determination.

### Unit - IV **Biophysical Chemistry**

#### **Bioenergetics-**

Standard free energy change in biochemical reaction, exergonic and endergonic reaction, hydrolysis of ATP, synthesis of ATP from ADP.

#### **Thermodynamics of Biopolymer Solutions**

Thermodynamics of biopolymer solutions osmotic pressure, membrane equilibrium, muscular contraction & energy generation in mechanochemical system.

#### **Transport of ions**

Ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport, nerve conduction.

#### **Biopolymers & their molecular weights**

Evaluation of size, shape molecular weight and extent of hydration of biopolymers by various experimental techniques like sedimentation and viscosity electrophoresis.

### **LIST OF REFERENCE BOOKS:**

1. Handbook of Biomolecules: Fundamentals, Properties and Applications, Dakeshwar Kumar Verma and CB Verma, Elsevier, Australia, 2023
2. Bioinorganic and supramolecular chemistry, P. S. Kalsi, New age international
3. Principles of structure and reactivity, J. E. Huheey, Ellen A. Keiter, Richard L. Keiter, Pearson education
4. Concise inorganic chemistry, J.D.Lee, Backwell science
5. Inorganic chemistry, Shriver and Atkins, Oxford
6. Inorganic chemistry, Catherine Housecraft, pearson education
7. Handbook of Biomolecules, CB Verma, Dakeshwar Verma, Elsevier, 2022.

		Departmental members	
Chairperson /H.O.D	<i>[Signature]</i> 25/5/24		
Subject Expert (University Nominee)	<i>[Signature]</i> 25/5/24	1.....	8..... <i>[Signature]</i> DLC
Subject Expert	<i>[Signature]</i> 25/5/24	2.....	9.....
Representative (Industry)		3..... <i>[Signature]</i>	10.....
Representative (Alumni)	<i>[Signature]</i>	4..... <i>[Signature]</i>	11.....
Representative (Professor Science Faculty Other Dept.)		5..... <i>[Signature]</i>	12.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**  
**SEMESTER - III**  
**2024-25**  
**PAPER- III**  
**ORGANOTRANSITION METAL COMPLEXES**

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**Max. Marks : 80**

**Min. Marks : 16**

- Unit - I      Alkyls and Aryl of Transition Metals-**  
Type, routes of synthesis, stability & decomposition pathways.  
**Compound of Transition Metals- Carbon Multiple Bonds-**  
Alkylidenes, alkylidynes, low valent carbene & carbene synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reaction on the ligands.
- Unit - II      Transition Metal  $\pi$ -Complexes**  
Transition Metal- $\pi$  complexes with unsaturated organomolecules, alkenes, alkynes, diene dienyl, arene and complexes, preparation, properties, nature of bonding and structural features and their characterization. Important reactions relating to nucleophilic and electrophilic attack on ligands.
- Unit - III      Transition Metal Compounds with Bonds to Hydrogen -**  
Preparation and characterization of Transition metal compounds with Bonds to hydrogen.  
**Fluxional organometallic Compounds-**  
Fluxional and dynamic equilibria in compounds such as  $\eta^2$  olefin,  $\eta^3$  allyl and dienyl complexes.  
**Sandwich Compounds:-**  
Ferrocene and other Metallocene, preparation, reaction and their spectral analysis
- Unit - IV      Stoichiometric reaction for catalysis, homogenous catalysis, hydrogenation, Zeiglar-Natta polymerization of olefins, catalytic reaction involving carbon monoxide such as hydrocarbonylation of olefin (oxo reaction), oxopalladation reaction activation of C-H bonds.**



**LIST OF REFERENCE BOOKS**

1. Organometallic Compounds: Synthesis, Reactions, and Applications, Dakeshwar Kumar Verma and J. Aslam, February 2023, ISBN:9783527351787, 2023 Wiley-VCH GmbH, Germany
2. Inorganic Chemistry ,Puri, Sharma, kalia, milestone publisher
3. Principles of structure and reactivity, J. E. Huheey, Ellen A. Keiter, Richard L. Keiter, Pearson education
4. Concise inorganic chemistry, J.D.Lee, Backwell science
5. Inorganic chemistry, Shriver and Atkins, Oxford
6. Inorganic chemistry, Catherine Housecraft, pearson education

		Departmental members	
Chairperson /H.O.D .....	<i>[Signature]</i> 25/5/24		
Subject Expert ..... (University Nominee)	<i>[Signature]</i> 25/5/24	1.....	8..... <i>[Signature]</i>
Subject Expert .....	<i>[Signature]</i> 25/5/24	2.....	9.....
Representative ..... (Industry)		3..... <i>[Signature]</i>	10.....
Representative ..... (Alumni)	<i>[Signature]</i>	4..... <i>[Signature]</i>	11.....
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DEPARTMENT OF CHEMISTRY  
GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON  
M.Sc. CHEMISTRY

SEMESTER III

2024-25

PAPER- IV

PHOTOINORGANIC AND ANALYTICAL CHEMISTRY

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Max. Marks : 80


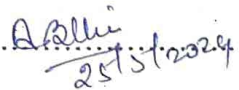






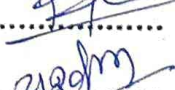

Min. Marks : 16

- Unit-I Error and Evaluation**  
Definition of terms in mean and median, precision, standard deviation. Relative standard deviation, accuracy absolute error, relative error, type of error in experimental data determinate (systematic), indeterminate of random and gross. Sources of errors and the effects upon the analytical results. Method for reporting analytical data, the use of statistics.  
**Analysis of soil, fuel, body fluids and drugs**  
Analysis of soil moisture, PH, Total nitrogen, phosphorus, lime manganese, sulphur and alkali salts.
- Unit - II Fuel analysis**  
Liquid and gas, liquid fuels, flash point, aniline points octane number, gaseous fuels, producer gas and water gas –calorific value.  
**Clinical chemistry**  
Composition of blood collection and preservation sample, clinical analysis, serum electrolytes, blood glucose, blood urea, uric acid, albumin barbiturary, immunoassay principle radioimmunoassay (RIA) and application. The blood group analysis, trace elements in the body.
- Unit - III Excited states of Metal complexes**  
Excited states of metal complexes, Comparisons with organic compounds, electronically excited states of metal complexes. Charge transfer spectra, charge transfer excitations, method for obtaining charge transfer spectra.
- Unit - IV Redox Reaction by Excited Metal Complexes**  
Energy transfer under condition of weak interaction and strong interaction – exciplex formation, condition of the excited states to be useful as redox reactions, excited electron transfer, metal complexes as attractive condition

(2,2-bipyridine and 1,10-phenanthroline complexes), illustration of reducing and oxidizing character of Ruthenium (bipyridine complexes).  
 Comparison with Fe(bipy)<sub>3</sub> role of spin – orbit coupling life time of comparison, application of redox process , transformation of low energy reaction into high energy products, chemical energy into light.

**LIST OF REFERENCES BOOKS:-**

1. Inorganic Chemistry, Puri, Sharma, kalia, milestone publisher
2. Principles of structure and reactivity, J. E. Huheey, Ellen A. Keiter, Richard L. Keiter, Pearson education
3. Concise inorganic chemistry, J.D.Lee, Backwell science
4. Inorganic chemistry, Shriver and Atkins, Oxford

		Departmental members	
Chairperson /H.O.D .....	 25/5/24		
Subject Expert ..... (University Nominee)	 25/5/2024	1.....	8..... 
Subject Expert.....	  25/05/24	2.....	9.....
Representative ..... (Industry)		3..... 	10.....
Representative ..... (Alumni)		4..... 	11.....
Representative ..... (Professor Science Faculty Other Dept.)		5..... 	12.....
		6..... 	13.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. Chemistry**  
**[Third Semester]**  
**Laboratory Course I**  
**ANALYTICAL PRACTICAL**  
**2024-25**

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M.M. 100

**MAJOR EXPERIMENTS**

**Analysis of ores and minerals**

1. Lime stone and dolomite: Silica, Sesquioxide ( $R_3O_3$ ) Ca, Mg. L.O.I. etc.
2. Haematite: Iron, Al, Ca, Mg. Acid insoluble & silica etc.
3. Bauxite: Silica, Fe, Al, Be & Ti etc.
4. Cement: Silica, Fe, Al, Ca, Mg &  $SO_4^{2-}$

**Flame Photometric Determinations**

1. Sodium and Potassium when present together
2. Calcium and Magnesium in tap water

**Gravimetric Estimation**

Determination of composition of Ni - DMG complex by gravimetric method.

**Quantitative organic analysis**

1. Estimation of sulphur by Messenger's Method.
2. Estimation of nitrogen by Kjeldahl Method.
3. Estimation of halogen by Fusion method / Stepnow's method.
4. Determination of the percentage of number of hydroxyl groups in an organic compound by acetylation method.
5. Estimation of amines/phenols using bromate bromide solution/or acetylation method.

**MINOR EXPERIMENTS**

**Spectroscopy Determinations**

1. To verify the additivities of absorbance of a mixture of coloured substance in  $KMnO_4$  and  $K_2Cr_2O_7$  solution.
2. Determination of stoichiometry and stability constant of inorganic and organic complexes.
3. To determine the indicator constant  $pK_a$  of methyl red spectrophotometrically.

4. Characterization of the complexes by electronic and IR spectral data.
5. Manganese / Chromium / Vanadium in steel sample
6. Nickel / Molybdenum / Tungsten / Vanadium / Uranium by extractive spectrophotometric method.
7. Fluoride / Nitrite / Phosphate
8. Iron-phenanthroline complex: Job's Method of continuous variations.
9. Copper - Ethylene diamine complex: Slope-ratio method

**Conductometry**

1. To verify Debye Huckel Onsager limiting law for strong electrolytes.
2. Determination of the activity coefficient of zinc ions in the solution of 0.002 M zinc sulphate using Debye Huckel's law.
3. To determine the degree of hydrolysis and hydrolysis constant of  $\text{NH}_4\text{Cl}$  /aniline hydrochloride at room temperature.
4. To study the effect of solvent on the conductance of acetic acid.

	Departmental members	
Chairperson /H.O.D. <i>[Signature]</i> .....2.5.1.5.24		
Subject Expert <i>[Signature]</i> ..... (University Nominee) <i>[Signature]</i>	1.....	8..... <i>[Signature]</i>
Subject Expert <i>[Signature]</i> ..... <i>[Signature]</i>	2.....	9.....
Representative ..... (Industry)	3..... <i>[Signature]</i>	10.....
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	6..... <i>[Signature]</i>	13.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. Chemistry**  
**[Third Semester]**  
**Laboratory Course II**  
**PROJECT**  
**2024-25**

M.M. 100

Each student will be allotted one project of 100 marks. The project can be either theoretical or experimental.

Distribution of marks:-

Project work	-	60
Presentation	-	20
Viva	-	20
Total	-	100

	Departmental members	
Chairperson /H.O.D ..... <i>[Signature]</i> 26/5/24	1.....	8..... <i>[Signature]</i>
Subject Expert ..... <i>[Signature]</i> 25/5/24 (University Nominee)	2.....	9.....
Subject Expert ..... <i>[Signature]</i> AKJ 25/05/24	3..... <i>[Signature]</i>	10.....
Representative ..... (Industry)	4..... <i>[Signature]</i>	11.....
Representative ..... <i>[Signature]</i> (Alumni)	5..... <i>[Signature]</i>	12.....
Representative ..... (Professor Science Faculty Other Dept.)	6..... <i>[Signature]</i>	13.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS**  
**COLLEGE, RAJNANDGAON (C.G.)**



**M.Sc. Chemistry**

**Fourth Semester**

**2024-25**

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**Syllabus and Marking Scheme for Fourth Semester**

Session 2024-25

Paper No.	Title of the Paper	Marks Allotted in Theory		Marks Allotted in Internal Assessment		Credits
		Max	Min	Max.	Min.	
I	PHOTOCHEMISTRY AND SOLID STATE	80	16	20	04	04
II	ENVIRONMENTAL CHEMISTRY	80	16	20	04	04
III	BIO-INORGANIC AND SUPRAMOLECULAR CHEMISTRY	80	16	20	04	04
IV	CHEMISTRY OF MATERIALS AND RADIOCHEMISTRY	80	16	20	04	04
V	Lab Course I ANALYTICAL CHEMISTRY	100	36	----	----	02
IV	Lab Course II PROJECT	100	36	----	----	02
	<b>Total</b>	<b>520</b>	<b>—</b>	<b>80</b>	<b>—</b>	<b>20</b>

04 Theory papers	-	320
04 Internal Assessments	-	80
01 Practical + 01 Project	-	200
<b>Total Marks</b>	-	<b>600</b>

**Note: 25 marks = 01 credit in Theory Papers and 50 Marks = 01 Credit in Practical/Project work**



DEPARTMENT OF CHEMISTRY  
GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON  
M.Sc. CHEMISTRY

SEMESTER IV

2024-25

PAPER- I

PHOTOCHEMISTRY AND SOLID STATE

---

Max. Marks : 80

Min. Marks : 16

- Unit-I Photochemical reaction**  
Interaction of electromagnetic radiation with matter, type of excitations, fate of excited molecules, Quantum yield, transfer of excitation energy, actinometry.  
**Determination of reaction mechanism-**  
Classification, rate constant and life times of reactive energy states determination of rate constant of reaction, effect of light intensity on the rate of photochemical reaction, types of photochemical reaction, photo dissociation, gas phase photolysis.
- Unit - II Photochemistry of Alkenes and Carbonyl Compound -**  
Intramolecular reaction of the olefinic bond geometric isomerism, cyclisation reaction, rearrangement of 1,4, & 1, 5, dienes. Intramolecular reaction of carbonyl compounds, unsaturated compounds.  
**Miscellaneous Photochemical Reaction :-**  
Photo Fries Rearrangement and Barton reaction.
- Unit - III A. Solid state chemistry :-**  
General principles, experiment procedures, co- precipitation as a precursor to solid state reaction, kinetics of solid chemistry.  
**B. Crystal defects and non stoichiometry -**  
Perfect & imperfect crystal, intrinsic defects- point defects, line & plane defects. Thermodynamics of Schottky & Frenkel defects formation. Colour centers, non- stoichiometry & defects.
- Unit - IV A. Electronic properties & band theory-**  
Metal, insulators & semiconductors, electronic structure of solid- band theory, bond structure of metals, insulators semiconductors, intrinsic & extrinsic semiconductors doping semiconductors, p-n junction, superconductors.

**B. Photoconduction- photoelectric effects-**

Quantum theory of paramagnetic- co-operative phenomenon magnetic domains, hysteresis.

**LIST OF REFERENCE BOOKS:**

1. Principles of the Solid State, H.V. Keer, Wiley Eastern.
2. Solid State Chemistry, N.B. Hannay
3. Solid State Chemistry, A.K. Chakrobarty, New Age International.
4. Solid State Chemistry and its Application, A.R. West, Plenum.
5. Fundamentals of Photochemistry, K.K. Rohtagi - Mukherji, Wiley- Eastern.
6. Molecular Photochemistry, N.J. Turro, W.A. Benjamin.
7. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.
8. Photochemistry, R.P. Kundall and A Gilbert, Thomson Nelson.

		Departmental members	
Chairperson /H.O.D.....			
Subject Expert ..... (University Nominee)	A. B. S. 25/5/24	1.....	8.....
Subject Expert.....	25/5/24	2.....	9.....
Representative ..... (Industry)		3.....	10.....
Representative ..... (Alumni)	W. B. S.	4.....	11.....
Representative ..... (Professor Science Faculty Other Dept.)		5.....	12.....
		6.....	13.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**

**Semester IV**

**2024-25**

**Paper - II**

**ENVIRONMENTAL CHEMISTRY**

---

**Max. Marks : 80**

**Min. Marks : 16**

**Unit - I A. Environment**

Introduction, composition of atmosphere, vertical temperature budget of the earth atmosphere system, vertical stability atmosphere. Biogeochemical cycles of C.N.P.S. and biodistribution of elements.

**Unit - II Hydrosphere**

Chemical composition of water bodies, Hydrological cycle. Aquatic pollution inorganic organic pesticide, agricultural, industrial & sewage , detergent, oil spill and oil pollutants, water quantity parameter dissolved oxygen, biochemical oxygen demand, solid metal, content of chloride , sulphate, nitrate and microorganism, water quality standards. Analytical method for measuring BOD.DO.COD, residual chloride and chloride demand. Purification and treatment of water.

**Solids**

Composition, micro, and macro nutrient, pollutants waste treatment.

**Unit - III Atmosphere**

chemical composition of atmosphere, chemical and photochemical reaction in atmosphere, smog formation, oxides of Nox and their effect, pollution by chemicals, VOC'S chloroflouro hydro carbons. Green house effect, acid rain, air pollution controls

**Unit - IV Industrial pollution**

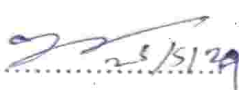
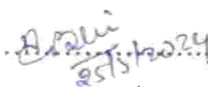

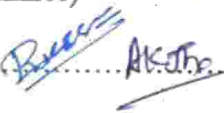
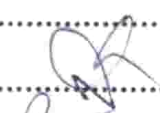
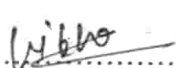
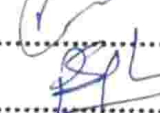
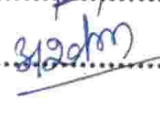
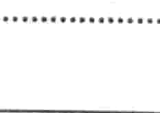
Cement, distillery, paper and pulp, thermal power, plants, nuclear power plants.

**Environmental Toxicology**

Chemical solution to environmental problems, biodegradability, principles of decomposition, better industrial processes, Bhopal gas tragedy.

**LIST OF REFERENCE BOOKS**

1. Environmental chemistry, A. K. De, New Age International
2. Environmental Chemistry: Green chemistry and pollutants and ecosystem, Eric Lichtouse
3. Environmental Chemistry, Sameer K. bainergi
4. Environmental Chemistry, P. S. sindhu, New Age International
5. A text Book of Environmental Chemistry, Subramanyan
6. A text Book of Environmental Chemistry and pollution control, S. S. Dara, S Chand
7. Environmental Chemistry, B. K. Sharma, Krishna Publication

		Departmental members	
Chairperson /H.O.D .....			
Subject Expert ..... (University Nominee)		1.....	8..... 
Subject Expert.....		2.....	9.....
Representative ..... (Industry)		3..... 	10.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**

**SEMESTER IV**

**2024-25**

**PAPER- III**

**BIO-INORGANIC AND SUPRAMOLECULAR CHEMISTRY**

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**Max. Marks : 80**

**Min. Marks : 16**

- Unit - I Bioinorganic and supramolecular & photo inorganic chemistry-**  
Metal storage transport & Biomineralization Ferritin, transferrin & siderophores.  
**Calcium in Biology**  
Calcium in living cells, transport & regulation, molecular aspects of intramolecular processes, extracellular binding proteins,  
**Metal- nucleic Acid Interactions**  
Metals ion & metal complex interactions, metal complexes
- Unit - II Metalloenzymes-**  
Zinc enzyme- carboxypeptides and carbonic anhydrase.  
Iron enzyme- catalase, peroxidase & cytochrome P-450.  
Copper enzyme – superoxide dismutase. Molybdenum Oxatransferase enzyme- Xanthine oxidase. Coenzyme vitamin B
- Unit - III Metal and Metal chelates in Medicine**  
Metal & disease, toxic effect of metals, metal chelates used for diagnosis & chemotherapy with particular reference to anticancer drugs.  
**Antibiotics**  
Synthesis of penicillin G, Penicillin V, ampicillin, chlorphenical, amoxicillin
- Unit - IV Supramolecular chemistry : Concepts & Language**  
Molecular recognition, Molecular receptors for different types of molecules including arsenic substrates, design, & Synthesis of co receptor molecules and multiple recognition, Supramolecular reactivity and Catalysis.

**Transport process & carrier**

Supramolecular devices Supramolecular Photochemistry, supramolecular electronic, ionic & Switching devices. Some example of self assembly in supramolecular chemistry.

**LIST OF REFERENCE BOOKS**

1. Principles of structure and reactivity, J. E. Huheey, Ellen A. Keiter, Richard L. Keiter, Pearson education
2. Bioinorganic chemistry , K. Hussain Reddy, new age international
3. Concise inorganic chemistry, J.D.Lee, Backwell science
4. Inorganic chemistry, Shriver and Atkins, Oxford
5. Supramolecular chemistry- fundamental and application, Ariga, Katsuhiko, Kunitake, Toyoki, springer

		Departmental members	
Chairperson /H.O.D .....	<i>[Signature]</i>		
Subject Expert ..... (University Nominee)	<i>[Signature]</i>	1.....	8..... <i>[Signature]</i>
Subject Expert .....	<i>[Signature]</i> <i>[Signature]</i>	2.....	9.....
Representative ..... (Industry)		3..... <i>[Signature]</i>	10.....
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**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**

**SEMESTER IV**

**2024-25**

**PAPER- IV Elective - A**

**CHEMISTRY OF MATERIALS & RADIOCHEMISTRY**

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**Max. Marks : 80**

**Min. Marks : 16**

<b>Unit-I</b>	<b>Chemistry of materials</b> <b>Multiphase Materials</b> Ferrous alloys, stainless steels, and nonferrous alloys, properties of ferrous and non-ferrous alloys and their application. <b>Glasses, ceramics and refractories</b> Glassy state, glass formers and glass modifiers, application. Ceramic structures, Mechanical properties clay products. Refractories, characterizations, properties & application
<b>Unit II</b>	<b>Composites</b> Introduction, Classifications, Binary and ternary composites based on metals, metal oxides, polymers, carbon allotropes and their energy storage, biomedical and environmental radiation applications. <b>Nanomaterials</b> Fundamental aspects, preparation methods, Characterization techniques-FTIR, UV-Vis, SEM, EDS, XPS and TEM, Their application towards antimicrobial, antifungal, anticancer, dyes remediation, environmental radiation applications.
<b>Unit - III</b>	<b>Principle and application of TGA, DTA, &amp; DSC.</b> <b>Polarimetry, Optical Rotatory Dispersion and Circular Dichroism</b> Introduction, polarized light, optical activity, application of polarimetry, ORD and CD, rotator dispersion, instrumentation, cotton effect, anomalous ORD curves, relationship between ORD and CD, Axial haloketone rule, the octant rule, applications of octant rule, applications of ORD and CD, advantages of CD over ORD, limitations of ORD and CD.
<b>Unit - IV</b>	<b>Radiation Chemistry</b> Primary radiation effects. Radiation dosimetry, Radio free radicals, Radiochemistry in different media, Radiation in chemical process. Industrial application of radiation.

Nuclear Models, stability of the nucleus, radio isotopes, application of Radio isotopes in physicochemical investigation.

**Radio analytical techniques** - Isotopic dilution methods, neutron activation analysis (NAA), radiometric titrations, measurement of radioactivity through with special reference to Gieger-Muller counter and application in agricultures and industry in health care in biology.

**LIST OF REFERENCE BOOKS:**

- 1 Carbon Dots: Recent Developments and Future Perspectives, Elyor Berdimurodov, Dakeshwar Kumar Verma, Lei Guo, April 2024 American Chemical Society, USA.
- 2 Carbon Dots in Biology: Synthesis, Properties, Biological and Pharmaceutical Applications, Berdimurodov Elyor Tukhliyivich and Dakeshwar Kumar Verma, 2024, De-Gruyter, Germany.
- 3 Instrumental Technique of Analytical Chemistry, H. Kour, Pragati Publication
- 4 Nanoparticles – Nanocomposites, Nanomaterials: An Introduction for beginners, Dieter Volarth, Villey –VCH
- 5 Composite Materials: Production Properties Testing, K. Shrinivasan, Narosa
- 6 Composite Materials, Shivanand, Ashian Book Publication
- 7 PhotoChemistry and Radiation Chemistry, James F. Wishart, Danial G. Nausera

		Departmental members	
Chairperson /H.O.D .....			
Subject Expert ..... <u>ADU</u> (University Nominee)	1.....	8.....	<u>[Signature]</u> D.C.
Subject Expert. <u>[Signature]</u> <u>[Signature]</u>	2.....	9.....	
Representative .....	3..... <u>[Signature]</u>	10.....	
(Industry)	4.....	11.....	
Representative ..... <u>[Signature]</u>	5..... <u>[Signature]</u>	12.....	
(Alumni)	6..... <u>[Signature]</u>	13.....	
Representative .....	7.....	14.....	
(Professor Science Faculty Other Dept.)			



**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. CHEMISTRY**  
**SEMESTER IV**  
**2024-25**  
**PAPER- IV Elective - B**  
**POLYMER CHEMISTRY**

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**Max. Marks 80**

**Min. Marks 16**

**Unit - I      Mechanism of Polymerization**

Basic concepts- Monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization: Mechanism of condensation polymerization, mechanism of addition polymerization – free radical chain, cationic, anionic, coordination and mechanism of copolymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous systems.

**Unit - II      Kinetics and Statistics of Polymerization**

Kinetics and statistics of stepwise polymerization – reactivity and molecular size, kinetics and statistics, molecular weight control. Kinetics of free radical chain polymerization, equation for kinetic chain length, degree of polymerization and chain transfer; Kinetics of cationic polymerization; kinetics of anionic polymerization. Kinetics of heterogeneous polymerization using Ziegler Natta catalysts.

**Unit - III      Structure and Properties**

Morphology and order in crystalline polymers - configurations of polymer chains. Crystal structures of polymers. Polymer structure and physical properties- crystalline melting point  $T_m$  - melting points of homogenous series, 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.

**Unit - IV Polymer Processing**

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

**Polymer Characterization**

Polymer solutions – Criteria of polymer solubility, thermodynamics of polymer solution – ideal solution, entropy, heat and free energy of mixing.

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.

**LIST OF REFERENCE BOOKS**

1. Polymer Science, Gowarikar, Vishwanathan, Sridhar, Willey Eastern.
2. Textbook of Polymer Science, F.W. Billmeyer, Jr. Wiley
3. Contemporary Polymer Chemistry, Alcock and Lambe, Prentice Hall.
4. Physics and Chemistry of Polymers, J.M.G. Cowic, Blackie, Acadand Professional.
5. Funtional Monomers and Polymers, K. Takemoto, Y. Inaki and R.M. Ottanbrite.

		Departmental members	
Chairperson /H.O.D .....	<i>[Signature]</i>	1.....	8..... <i>[Signature]</i>
Subject Expert ..... (University Nominee)	<i>[Signature]</i> A. As. Thara	2.....	9.....
Subject Expert.....	<i>[Signature]</i> <i>[Signature]</i>	3..... <i>[Signature]</i>	10.....
Representative ..... (Industry)		4..... <i>[Signature]</i>	11.....
Representative ..... (Alumni)	<i>[Signature]</i>	5..... <i>[Signature]</i>	12.....
Representative ..... (Professor Science Faculty Other Dept.)		6..... <i>[Signature]</i>	13.....
		7.....	14.....

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON**  
**M.Sc. Chemistry**  
**[Fourth Semester]**  
**2024-25**  
**Lab Course I**  
**PROJECT WORK**

Max. Marks 100

Each student will be allotted one project of 100 marks. The project can be either theoretical or experimental.

Distribution of marks:-

Project work	-	60
Presentation	-	20
Viva	-	20
Total	-	100

	Departmental members	
Chairperson /H.O.D ..... <i>[Signature]</i>		
Subject Expert ..... <i>[Signature]</i> (University Nominee)	1.....	8..... <i>[Signature]</i>
Subject Expert..... <i>[Signature]</i> <i>[Signature]</i>	2.....	9.....
Representative ..... (Industry)	3..... <i>[Signature]</i>	10.....
Representative ..... <i>[Signature]</i> (Alumni)	4..... <i>[Signature]</i>	11.....
Representative ..... (Professor Science Faculty Other Dept.)	5..... <i>[Signature]</i>	12.....
	6..... <i>[Signature]</i>	13.....
	7.....	14.....

**DEPARTMENT OF CHEMISTRY**  
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**M.Sc. Chemistry**  
**[Fourth Semester]**  
**2024-25**  
**Lab Course-II**

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**Max. Marks : 100**

**MAJOR EXPERIMENTS**

**Analysis of alloys, ores and minerals**

- (i) Ni alloy
- (ii) Cu, Ni, Zn alloy
- (iii) Steel
- (iv) Solder metals
- (v) Gun metals
- (vi) Types metals
- (vii) Coin analysis

**MINOR EXPERIMENTS**

**EXTRACTION OF ORGANIC COMPOUNDS FROM NATURAL SOURCES**

- (i) Isolation of caffeine from leaves.
- (ii) Isolation of Casein from milk.
- (iii) Isolation of lactose from milk.
- (iv) Isolation of nicotine dipicrate from tobacco.
- (v) Isolation of Cinchonine from cinchona bark.
- (vi) Isolation of Piperine from black pepper.
- (vii) Isolation Lycopene from tomatoes.
- (viii) Isolation of  $\beta$ -Carotene from carrots.
- (ix) Isolation of Limonene from citrus rinds.
- (x) Isolation of protein and carbohydrates from seeds –colour test
- (xi) Extraction of Fatty oil from seeds and determination of refractive index of the oil.
- (xii) Isolation of protein and carbohydrate (as reducing sugars) from seed-colour test.

**BOOKS SUGGESTED :**

1. Practical Organic chemistry by A. I. Vogel.
2. Practical Organic chemistry by Mann and Saunders.

3. Practical Organic chemistry by Garg and Saluja.
4. The Systematic Identification of Organic compounds, R. L. Shriner and D. Y. Curtin.
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 preparation, P. J. Hill.
8. Experimental Biochemistry, by B.S.Roa and V.Deshpande. I.K. International Pvt. Ltd.
9. Comprehensive Practical Organic Chemistry, Preparation and Qualitative Analysis, V.K.Ahluwalia and Renu Aggarwal, University Press.

		Departmental members	
Chairperson /H.O.D	<u>25/5/24</u>		
Subject Expert (University Nominee)	<u>Saluja</u>	1.....	8.....
Subject Expert	<u>Ruani</u> <u>AK Sha</u>	2.....	9.....
Representative (Industry)		3.....	10.....
Representative (Alumni)	<u>Wibhe</u>	4.....	11.....
Representative (Professor Science Faculty Other Dept.)		5.....	12.....
		6.....	13.....
		7.....	14.....

**DEPARTMENT OF CHEMISTRY**  
**GOVT. DIGVIJAY PG AUTONOMOUS**  
**COLLEGE, RAJNANDGAON (C.G.)**



**SYLLABUS**

**CERTIFICATE COURSE**

**On**

**Advanced Techniques for Soil and Water Analysis**

**2024 -25**

**DURATION** : 3 Months

**CERTIFICATE COURSE** : Advanced Techniques for Soil and  
Water Analysis

**MARKS DISTRIBUTION**

**THEORY PAPER** :

Maximum marks = 50 marks

**PROJECT WORK** :

Maximum marks = 50 marks

DEPARTMENT OF CHEMISTRY  
GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON

CERTIFICATE COURSE  
On  
Advanced Techniques for Soil and Water Analysis

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Max. Marks : 50

**Soil Analysis**

Introduction, Sampling, Analysis of soil moisture, PH, Total nitrogen, phosphorus, lime, manganese, sulphur and alkali salts, analysis of micro and macronutrients, effects on plant and animal health

**Water Analysis**

Introduction, Sources of water pollution, Sampling techniques, water quality parameters dissolved oxygen, biochemical oxygen demand, solid metal, content of chloride, sulphate, nitrate and microorganism, water quality standards, Analytical method for measuring BOD, DO, COD, residual chloride and chloride, nitrate, sulphate, fluorides, phosphates, Hardness

**Atomic Absorption Spectroscopy**

Physical principles, individual steps of an analytical method, techniques of atomic absorption spectrometry, detection of individual elements for Cadmium (Cd), Calcium (Ca), Magnesium (Mg), Manganese (Mn), Iron (Fe), Zinc (Zn)

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DEPARTMENT OF CHEMISTRY



GOVT. DIGVIJAY PG AUTONOMOUS COLLEGE, RAJNANDGAON

CERTIFICATE COURSE

On

Advanced Techniques for Soil and Water Analysis

PROJECT WORK

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Max. Marks 50

Each student will be allotted one project of 100 marks. The project can be either theoretical or experimental.

Distribution of marks:-

Project work	-	30
Presentation	-	10
Viva	-	10
Total	-	50

*Praveen*

		Departmental members	
Chairperson /H.O.D .....			
Subject Expert ..... (University Nominee)	<u>A. Alhawi</u> A. Alhawi	1.....	8..... <u>R. Sa</u>
Subject Expert.....	<u>B. Alhawi</u>	2..... <u>R. Al</u>	9.....
Representative ..... (Industry)		3.....	10.....
Representative ..... (Alumni)	<u>W. Alhawi</u>	4..... <u>W. Al</u>	11.....
Representative ..... (Professor Science Faculty Other Dept.)		5.....	12.....
		6..... <u>S. Alhawi</u>	13.....
		7.....	14.....