



# PROF. RAJENDRA SINGH (RAJU BHAIYA) UNIVERSITY, PRAYAGRAJ

Structure of Syllabus for the Program: M.Sc.

Subject: CHEMISTRY

(Session: 2022-2023 onwards)

Structure of Syllabus Developed by			
Name of BoS Convener/ BoS Member	Designation	Department	College/ University
Dr Archana Sinha	Professor & Convenor	Physics	K.A.Degree College, Prayagraj
Dr. Poonam Shukla	Assistant Professor & member	Chemistry	H.N.B.Govt.P.G.College, Naini, Prayagraj
Dr. Vipin Kumar	Assistant Professor & member	Chemistry	H.N.B.Govt.P.G.College, Naini, Prayagraj
Dr. Neeti Mishra	Assistant Professor & member	Chemistry	Bhavans Mehata DegreeCollege, Kaushambi
Prof. Ramendra Singh	Professor & expert	Chemistry	University of Allahabad
Prof. Ram Asre Singh	Professor & expert	Chemistry	T.D.College, Jaunpur
Dr. Vinay Kumar Singh	Associate Professor & expert	Chemistry	Dr. Shkuntala Mishra University, Lucknow

Course Code		Course Title	Credits	T/P	Evaluation	
					CIE	ETE
A	B	C	D	E	F	G
<b>SEMESTER I (YEAR I)</b>						
<b>B020701T</b>	CORE	<b>INORGANIC CHEMISTRY</b>	5	T	25	75
<b>B020702T</b>	CORE	<b>ORGANIC CHEMISTRY</b>	5	T	25	75
<b>B020703T</b>	CORE	<b>PHYSICAL CHEMISTRY</b>	5	T	25	75
<b>B020704T</b>	FIRST ELECTIVE (Select any one)	<b>TECHNIQUES OF CHEMISTRY-I</b>	5	T	25	75
<b>B020705T</b>		<b>POLYMER CHEMISTRY</b>				
<b>B020706P</b>	SECOND ELECTIVE (Select any one)	<b>CHEMISTRY LABORATORY-I</b>	4	P	50	50
<b>B020707P</b>		<b>PROJECT PRESENTATION</b>				
<b>SEMESTER II (YEAR I)</b>						
<b>B020801T</b>	CORE	<b>INORGANIC CHEMISTRY</b>	5	T	25	75
<b>B020802T</b>	CORE	<b>ORGANIC CHEMISTRY</b>	5	T	25	75
<b>B020803T</b>	CORE	<b>PHYSICAL CHEMISTRY</b>	5	T	25	75
<b>B020804T</b>	THIRD ELECTIVE (Select any one)	<b>TECHNIQUES OF CHEMISTRY-II</b>	5	T	25	75
<b>B020805T</b>		<b>SUPRA-MOLECULAR CHEMISTRY AND STRATEGIES IN CHEMICAL SYNTHESIS</b>				
<b>B020806P</b>	FOURTH ELECTIVE (Select any one)	<b>CHEMISTRY LABORATORY-II</b>	4	P	50	50
<b>B020807P</b>		<b>INDUSTRIAL TRAINING AND PRESENTATION</b>				

SEMESTER III (YEAR II)						
B020901T	CORE	SPECTROSCOPY	5	T	25	75
B020902T	CORE	MOLECULAR REARRANGEMENTS & PHOTOCHEMISTRY	5	T	25	75
B020903T	CORE	ANALYTICAL CHEMISTRY	5	T	25	75
B020904T	FIFTH ELECTIVE (Select any one)	NANO MATERIALS & SOLID STATE CHEMISTRY	5	T	25	75
B020905T		INORGANIC SPECTROSCOPY				
B020906P	SIXTH ELECTIVE (Select any one)	CHEMISTRY LABORATORY-III	4	P	50	50
B020907P		INTERNSHIP IN CHEMICAL INDUSTRY				
SEMESTER IV (YEAR II)						
B021001T	CORE	ORGANOMETALLIC CHEMISTRY	5	T	25	75
B021002T	CORE	SOME SPECIFIC REACTIONS AND REAGENTS IN CHEMISTRY	5	T	25	75
B021003T	SEVENTH ELECTIVE (Select any one)	CHEMISTRY OF NATURAL PRODUCTS	4	T	25	75
B021004T		MEDICINE CHEMISTRY				
B021005R	RESEARCH PROJECT/ DISSERTATION	MAJOR RESEARCH PROJECT/ DISSERTATION	10	R	50	50

**NOTE:**

1. Do not mark any Code/Information in Column-A, it will be indorsed by the University.
2. T/P in Column-E stands for Theory/Practical.
3. CIE in Column-F stands for 'Continuous Internal Evaluation' and depicts the maximum internal marks. Respective examination will be conducted by subject teacher.
4. ETE in Column-G stands for 'External Evaluation' and depicts the maximum external marks. Respective Examination will be conducted by the University.
5. Column-B defines the nature of course/paper. The word **CORE** herein stands for **Compulsory Subject Paper**.
6. Column-D depicts the credits assigned for the corresponding course/paper.
7. **First Elective:** It will be a Subject Elective. Students may select one of the two subject papers under this category.
8. **Second Elective:** It will designate a Practical Paper or equivalently a Field Visit or Project Presentation. In case of Field Visit, student is required to submit a detailed report of the visit for the purpose of evaluation. The report should include the observational features and benefits of the visit. In case of Project Presentation, the student may be assigned to go for a survey/practical or theoretical project/assignment or seminar with presentation.
9. **Third Elective:** It will be a Subject Elective. Students may select one of the two subject papers under this category.
10. **Fourth Elective:** It will accommodate a practical paper or Industrial Training or Project Presentation. In case of Industrial Training, student may be allowed for the summer training and is required to submit a detailed training report including training certificate for the evaluation.
11. **Fifth Elective:** It will be a Subject Elective. Students may select one of the two subject papers under this category.
12. **Sixth Elective:** It will be a Practical Paper or equivalently a Project Presentation based on Survey/ Seminar/ Assignment. In case of Project Presentation, student has to submit an exhaustive report on respective topic and to face an open presentation for the evaluation.
13. **Seventh Elective:** It will be a Generic Elective. The student may study or receive training of the any subject of his interest (depends on the availability in his institution of enrollment).
14. **Master Research Project:** It will be a Major Research Project or equivalently a research-oriented Dissertation on the allotted topic. The student will have to complete his/her research project under any supervisor. The supervisor and the topic for research project shall be allotted in second semester. The student straight away will be awarded 05 credits if he publishes a research paper on the topic of Research Project or Dissertation.

**SEMESTER -I**  
**Paper First(Core)**

**INORGANIC CHEMISTRY**

**I. Stereochemistry and Bonding in main group compounds:**

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.

**II. Metal-Ligand Bonding in Transition Metal Complexes**

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

**III. Molecular symmetry and character tables**

Symmetry elements and symmetry operations, symmetry groups, defining properties of a group, character tables and its applications.

Symmetry considerations in simple inorganic and coordination compounds.

**IV. Chemistry of f-Block Elements**

Comparative study of lanthanides and actinides. Electronic configuration, Oxidation state, Ionic radii (lanthanide contraction), complex formation, Structure of complexes, spectral properties and magnetic properties. General chemistry of actinides including E.M.F. diagrams, Extraction and metallurgy of thorium and uranium. Separation of transamericium elements.

**V. Metal ligand equilibria in solution:**

Stepwise and overall formation constant, trends in stepwise constant, factors affecting the stability of metal complex with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin.



**SEMESTER- I**  
**Paper Second(Core)**

**ORGANIC CHEMISTRY**

**I- Nature of bonding in organic molecules:**

Delocalised chemical bonding-conjugation, crossconjugation, resonance, hyperconjugation, Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy of pi-molecular orbitals, annulenes, anti-aromaticity, homo-aromaticity. Bonding in fullerenes.

**II - Reaction Mechanism: Structure and Reactivity:**

Generation, structure stability and fate of reaction intermediates: carbocation(including nonclassical carbocation, phenonium ion, and norbornyl system), carbanion (including enolate ions), carbene, nitrenes, free radicals(allylic halogenation) and arynes. Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates. Methods of determining mechanism-isotope effects, product analysis. Kinetic and stereochemical studies.

**III. Stereochemistry**

Conformational analysis of cycloalkanes-disubstitutedcyclohexanes, decalins, effect of conformation on reactivity.

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

**IV Aliphatic Nucleophilic Substitution**

The  $S_N^1$ ,  $S_N^2$ , mixed  $S_N1'$ ,  $S_N2'$ ,  $S_N^i$  and SET mechanisms.

neighbouring group participation by pi and sigma bonds, anchimeric assistance. Nucleophilic substitution at allylic, aliphatic trigonal and vinylic carbon. Effects of substrate structure, attacking nucleophile, leaving group and reaction medium on reactivity. Phase transfer catalysis, ambident nucleophile and regioselectivity. Stereochemistry of  $S_N^1$  and  $S_N^2$  reactions.

**V. Aromatic Electrophilic Substitution**

The arenium ion mechanism, orientation and reactivity, energy-profile diagrams. The ortho/para ratio, ipso attack. Diazonium coupling, Vilsmeier reaction, Gatterman-Koch reaction..

**VI. Aromatic Nucleophile Substitution**

The  $ArSN^1$ ,  $ArSN^2$  &  $ArSN^i$  via benzyne mechanisms. Effect of substrate structure, leaving group and attacking nucleophile on reactivity. The Von Richter, Sommelet-Hauser and Smiles rearrangements.



**SEMESTER- I**  
**Paper Third(Core)**  
**PHYSICAL CHEMISTRY**

**I. Partial Molar Properties, Nernst Heat Theorem (NHT) and Third Law of Thermodynamics:**

Partial molar properties, Chemical potential and other thermodynamic functions, Fugacity of real gases, Nernst Heat Theorem and its application to non-condensed systems. Statement of the third law of thermodynamics. Derivation of unattainability of absolute zero. The relationship between entropy constant and Nernst chemical constant. Determination of entropy from the Third Law using the correction due to gas imperfections.

**II. Statistical Thermodynamics:**

Quantum states and complexions. The combinatory rule, system with definite total energy. Degeneracy of energy levels, probability and most probable distribution, in distinguishability, Maxwell-Boltzmann statistics, partition function, translational, rotational, vibrational, nuclear and electronic partition functions. Internal energy and heat capacity in terms of partition function.

**III. Spectroscopy:**

**Molecular Spectra**-Basic concepts of molecular spectroscopy. Classification of spectra, characterization of electromagnetic radiations. Regions of the spectrum.

**Rotation Spectra**-Rigid and non-rigid rotation spectra, selection rule, centrifugal distortion, isotopic shift. Spectra of polyatomic molecules, rotational constant. Experimental techniques.

**Vibration rotation spectra** -Simple harmonic oscillator, vibrational energy, anharmonicity, principle of vibration-rotation spectra, selection rule, PQR branches. Vibration in polyatomic molecules, effect of nuclear spin, isotopic shift, group frequency. Experimental techniques.

**IV Chemistry of Macromolecules:**

Introduction, type of polymers. Step polymerization, kinetics of step polymerization. Statistical approach to Gelation, Molecular weight distribution in linear poly condensation (Derivation of size distribution), Molecular weight averages. Methods of determining molecular weight by osmotic pressure, light scattering, sedimentation and viscosity methods.

**SEMESTER-I**  
**Paper Fourth**  
**(First Elective)**

**Techniques of Chemistry-I**

**1. Data handling in Analysis:**

Accuracy and precision. Errors, determinate and indeterminate errors, significant figures. Rounding off figures, standard deviation, regression analysis.

**2. Separation Techniques:**

Principles and applications of solvent extraction. Quantitative treatments of extraction equilibria. Solvent extraction of metals. Solid phase extraction.

**3. Chromatography:**

Introduction, principle, and experimental setup of chromatography. Partition and Adsorption chromatography: Principle of partition and adsorption chromatography. Mobile and stationary phases. liquid-liquid, gas-liquid, gas-solid and liquid-solid chromatography. Reversed phase partition chromatography, paper and thin layer chromatography Applications of partition and adsorption chromatography., HPLC.

**4. Ion Exchange resins:**

Mechanism of ion exchange. Factors affecting the selection of ion exchange resins. Techniques in ion exchange methods and analytical applications.

**5. Spot tests:**

Spot tests for metal ions, spot tests for identification of functional groups-hydroxyl, carboxylic, nitro, nitroso, azo and amino.

**6. Thermal Methods of Analysis:**

Principle, methodology and applications: Thermogravimetric and differential thermal Analysis, thermometric titrations. Thermal stability of polymers. Decomposition Pattern and decomposition reactions- examples.



**SEMESTER-I**  
**Paper Fourth**  
**(First Elective)**  
**POLYMER CHEMISTRY**

**I. Basics**

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

**II. Polymer Characterization**

Polydispersion-average molecular weight concept. Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular-weights. Endgroup, viscosity, light scattering, osmotic and ultracentrifugation methods.

**III. Analysis and testing of polymers**

Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Thermal analysis and physical testing-tensile strength. Fatigue, impact tear resistance, hardness and abrasion resistance.

**IV. Inorganic Polymers**

A general survey and scope of inorganic polymers special characteristics, classification, homo and hetero atomic polymers. Structure, properties and applications of (1) Polymers based on boron-borazines, boranes and carboranes. (2) Polymers based on silicon, silicones, polymetalloxanes and polymetallosiloxanes, silazanes.

**V. Structure, Properties and Application of**

- a. Polymers based on Phosphorous-Phosphazenes, Polyphosphates.
- b. Polymers based on Sulphur-tetrasulphurtetranitride and related compounds.
- c. Co-ordination and metal chelate polymers.



**SEMESTER II**  
**Paper First(Core)**

**INORGANIC CHEMISTRY**

**I. Term Symbols and Basic Principles of Electronic Spectroscopy:**

Frank - Condon principle, spin and Laporte selection rules, band intensities, band-width. Number of microstates and term symbols for gaseous atoms/ions. Spin-orbit coupling in spectroscopic ground state of  $p^2$ , and  $d^2$  configurations and energies of J levels.

**II. Electronic Spectra of Transition Metal Complexes:**

Interpretation of electronic spectra using, Orgel and Tanabe - Sugano diagram for 3d transition metal complexes. Calculations of crystal field and ligand field parameters ( $Dq$ , B and  $\beta$  parameters), nephelauxetic series and charge transfer spectra.

**III. Reaction mechanism of transition metal complexes(octahedral)**

Energy profile of reaction, reactivity of metal complexes, inert and labile complexes. Mechanism and kinetics of substitution reaction. Acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct indirect evidence in favour of conjugate mechanism.

**IV. Reaction mechanism of transition metal complexes(square planer)**

Mechanism and kinetics of substitution reaction. The trans effect, redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer-sphere type reactions, cross reactions and Marcus-Hush theory, inner-sphere type reactions.

**V. Metal Clusters:**

Higher boranes, carboranes, metalloboranes and metallocarboranes.

Metal carbonyls and halide clusters.

Compounds with metal-metal multiple bonds

**SEMESTER II**  
**Paper Second(Core)**

**ORGANIC CHEMISTRY**

**I. Addition to Carbon-Carbon Multiple Bonds**

Mechanistic and stereochemical aspect of addition reaction involving electrophiles, nucleophiles and free radicals, regio and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydroboration, Michael reaction, Sharpless asymmetric epoxidation, stereochemistry of epoxidation and halolactonisation.

**II. Addition to Carbon-Hetero atom Multiple Bonds**

Generation of enolate ions and their Synthetic applications. Stereochemistry of Wittig reaction and Aldol condensation. Stobbe condensation reactions. Hydrolysis of esters.

**III. Elimination Reactions**

The E1, E2 and E1cB mechanisms, their stereochemistry and orientation. Effects of substrates, attacking base, the leaving group and the medium on reactivity. Mechanism and orientation in pyrolytic elimination. Peterson elimination, Stereochemistry of E2 reactions and pyrolytic eliminations.

**IV. Pericyclic Reactions**

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. 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,  $4n$ ,  $4n+2$  system,  $2+2$  addition of ketenes, 1-3 dipolar addition and chelotropic reactions.

**V. Sigmatropic rearrangement**

Suprafacial and antarafacial shift of H, sigmatropic shifts involving carbon moieties, retention and inversion of configuration. [3,3] and [5,5] sigmatropic rearrangements. Detailed treatment of Claisen and Cope-rearrangements. Fluxional tautomerism, Aza-Cope rearrangements. Introduction to Ene reaction. Simple problems on pericyclic reactions.



**SEMESTER II**  
**Paper Third(Core)**

**PHYSICAL CHEMISTRY**

- I. **Quantum Chemistry:** Origin of quantum theory. Black body radiation. Wien and Rayleigh-Jeans laws, Planck's law and energy of harmonic oscillator. Postulates of quantum mechanics. Three dimensional time independent Schrodinger wave equation, Eigen functions and Eigen values. Normalization and Orthogonality conditions. One dimensional harmonic oscillator. Tunnel effect. Eigen function and Eigen value of H-atom (Solutions not required), shapes of s, p, d and f- orbitals  
**Approximate Methods-Vibrational principle and its application to ground state H-atom. Radial and Angular distribution curves for H-atom**
- II. **Chemical Kinetics:** Thermodynamic formulation of rate constant. Comparison of collision and absolute reaction rate theories. Calculation of transmission coefficient. Transition State theory in solution. Primary and secondary salt effects in the light of mechanistic tests. The theory of Absolute reaction rates - for reactions between atoms and reactions between molecules in terms of partition function. Influence of ionic strength and dielectric constant. Explosive reactions.
- III. **Electrolytes:** Limitation of Arrhenius theory of electrolytic dissociation. Role of solvent and inter-ionic forces. Activity and activity coefficients, determination of activity coefficients, Debye- Huckel Theory of the structure of dilute ionic solution, charge density and electrical potential. Properties of ionic cloud, activity coefficients from Debye-Huckel theory. Limiting law and its verification. Debye-Huckel theory to more concentrated solutions. Partial molar quantities of electrolytic solutions, determination of partial molar volume.
- IV. **Solid State:** Crystal structures, Bragg's law and applications. Band structure of solid.



**SEMESTER-II**  
**Paper Fourth**  
**(Second Elective)**  
**Techniques of Chemistry-II**

1. **Interaction of electromagnetic radiation with matter:** Electromagnetic spectrum, mode of absorption of radiation by matter. Electronic, vibrational & rotational transitions.
2. **Absorption Laws:** Grothus-Draperis Law, Einstein's Law of photochemical equivalence, Quantum efficiency, Reasons for low & high quantum yields, photoelectric cell & photosensitization Lambert-Beer's Law.
3. **Spectrophotometric instrumentation:** Monochromators, sample cell, detectors types of instruments-single beam and double beam spectrophotometers. Applications of spectrophotometric methods in analysis.
4. **Conductometric methods:** Principle of analysis, measurement of conductance, analytical applications of conductometry, conductometric titrations.
5. **Sensors:** Chemical sensors: classification. sensitivity and limit of detection. Potentiometric sensors, gas sensors, Volta metric sensors.  
**Biosensors:** The enzyme electrode, biosensor based on ion-selective electrodes. Applications of enzyme electrodes. Biosensors based on plant and animal tissues. Applications of chemical and biosensors in agriculture, medicine and biochemical analyses.

## SEMESTER-II

### Paper Fourth (Second Elective)

#### Supramolecular Chemistry and Strategies in Chemical Syntheses

##### A. Supra molecular Chemistry:

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

##### B. Strategies in Syntheses:

###### I. Disconnection Approach:

An introduction to synthons and synthetic equivalents. functional group inter conversions, the importance of the order of events in organic synthesis, chemo selectivity, reversal of polarity (Umpolung reactivity).

###### II. One Group C-C Disconnections:

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

###### III. Three group C-C disconnections:

Diels-Alder reaction, 1-3 difunctionalised compounds,  $\alpha$ - $\beta$ -unsaturated carbonyl compounds. control in carbonyl condensations, 1-5- difunctionalised compounds.

##### C. Protecting Groups:

Principle of protection of alcohols and diols as acetals, amine, carbonyl, double bond, triple bond and carboxyl group.

**BOOKS SUGGESTED - SEMESTER-I SEMESTER-II**

**Paper First(Core)**

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. Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
5. Megnetochemistry, R.L. Carlin, Springer Verlag.
6. Comprehensive Coordination Chemistry ed., G. Wilkinson, R.D. Gillars and J.A. Mc Cleverty. Pergamon.



**BOOKS SUGGESTED – SEMESTER-I SEMESTER-II**

**Paper Second(Core)**

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, R.T. Morrison and R.N. Boyd. Prentice Hall.
6. Modern Organic Reaction H.O. House, Benjamin
7. Principles of Organic Synthesis, R.O.C. Normon and J.M. Coxon, Blackie Academic and professionla.
8. Perricyclic Reactions. S.M. Mukherji, Macmillan India.
9. Reaction Mecnanism 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.
12. Advanced Organic Chemistry, J.Singh and L.D.S Yadav, Pragati Prakashan, India.

**BOOKS SUGGESTED – SEMESTER-I SEMESTER-II**

**Paper Third(Core)**

1. Physical Chemistry P.W. Atkins, ELBS.
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata Mc Graw Hill.
3. Quantum Chemistry, Ira N. Levine. Prentice Hall.
4. Coulson's Valence, R.Mc Weeny, ELBS.
5. Chemical Kinetics, K.J. Laidler, Megraw-Hill.
6. Kinetics and Mechanism of Chemical Transformations J. Rajaraman and J.Kuriacose Mc Millan.
7. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.
8. Modern Electrochemistry Vol. I and Vol. II J.O.M. Bockris and A.K.N. Reddy, Plenum.
9. Introduction to Polymer Science V.R. Gowarīkar, N.V. Vishwanathan and J.Sridhar, Wiley Eastern.
10. Elements of Physical Chemistry, S. Glasstone and D.Lewis., McMillan, London.

**BOOKS SUGGESTED – SEMESTER-I****Paper Fourth  
(First Elective)**

1. Chromatographic Methods, A. Baithwaite and F.J.Smith., Chapman Hall, London.
2. Chromatography, E. Heftmann., Reinhold, New York.
3. Chromatographic Adsorption Analysis, H.H. Strain., Interscience, New York.
4. Modern Practice of Gas Chromatography, R.L.Grob., Wiley- Interscience, New York.
5. Techniques of Liquid Chromatography, C.F.Simpson., Wiley.
6. Practice of High Performance Liquid Chromatography, H.Engelhardt., Springer-Verlag, Berlin.
7. Practice of Thin Layer Chromatography, J.C. Touchstone and M.F. Dobbins., Wiley, New York.
8. Techniques of Chemistry, Ed.A. Weissberger., Interscience, London.
9. Ion Exchange: Theory and Practice, Friedrich Helfferich., Dover Publications, New York.
10. Ion Exchange in Analytical Chemistry, William Rieman and Herold F. Walton., Pergamon Press.
11. Encyclopedia of Analytical Chemistry, vol.1-15, R.A. Meyers., John Wiley.
12. Instrumental Methods of Chemical Analysis, G.W. Ewing, McGraw Hill.

**BOOKS SUGGESTED – SEMESTER-II****Paper Fourth  
(Second Elective)**

1. Visible And Ultraviolet Spectroscopy, R.C.Denney and R. Sinclair., Wiley, Chichester.
2. Elementary Organic Spectroscopy: Principles & Chemical Application, Y.R. Sharma., S. Chand, Ram Nagar, New Delhi.
3. Theory and Applications of Ultraviolet Spectroscopy, H.H. Jaffe and M. Archin., Wiley, New York,
4. Vogel's Textbook of Quantitative Inorganic Analysis, Eds J. Basset, R.C. Denney, G.H. Jeffrey and J. Mendhem., Longman, London.
5. Chemical Sensors and Biosensors, Rene Lalauze., Wiley.
6. Chemical Sensors and Biosensors, Brian R. Eggins., Wiley.
7. Biosensors, Rajmohan Joshi., Rediff books.



**BOOKS SUGGESTED – SEMESTER-I** **Paper Fourth  
(First Elective)**

1. Textbook of Polymer Science, F.W. Billmeyer Jr. Wiley.
2. Polymer Science, V.R. Gowarker, N.V. Viswanathan and J Sreedhar, Wiley-Eastern.
3. Functional Monomers and Polymers. K. Takemoto, Y. Inaki and RM. Rttanbrite.
4. Contemporary Polymer Chamistry, H.R. Alcock and F.W. Lambe, Prentice Hall.
5. Physics and Chemistry of Polymer, J.M.G. Cowie, Blackie Academic and Professional.

**BOOKS SUGGESTED – SEMESTER-II** **Paper Fourth  
(Second Elective)**

1. Designing organic Synthesis, S. Warren. Wiley.
2. Organic Synthesis-Concept, methods and Starting Materials, J.Fuhrhop and G. Penicillin. Verlage VCH.
3. Some modern methods of organic Synthesis. W. Carruthers Cambridge Univ. Press.
4. Modern Synthetic Reaction, H.O. House W.A. Benjamin.
5. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, J. March. Wiley.
6. Advanced Organic Chemistry Part B. F. A. Carey and R.J. Sundberg. Plenum Press.
7. Physical Organic Chemistry, N.S. Isaacs, ELBS. Longman.
8. Super molecular Chemistry: Concept and perspectives, J.M. Lehn, VCH
9. Bioinorganic, Bioorganic and Supramolecular Chemistry, P.S.Kalsi and J.P. Kalsi., New Age International.



## SEMESTER III

### Paper First(Core)

## SPECTROSCOPY

#### I. Ultraviolet and Visible Spectroscopy:

Various electronic transitions (185-800 nm). Beer-Lambert Law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fisher-Woodward rules for conjugated dienes and carbonyl compounds. Ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

#### II. Infrared Spectroscopy:

Vibrational transitions, modes of vibrations, selection rules. Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies. Overtones, combination bands and Fermi resonance. FTIR.

#### III. Proton Magnetic Resonance Spectroscopy ( $^1\text{H}$ NMR) :

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, measurement of chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), chemical exchange, spin-spin interaction and *j-j* coupling, dihedral angle. nuclear magnetic double resonance, solvent effects. Fourier transform technique, nuclear Overhauser effect (NOE).

Use of NMR in medical diagnostics.

#### IV. Carbon-13 NMR Spectroscopy:

General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbon). coupling constants.

An Introduction to Two dimensional NMR spectroscopy - COSY. NOESY and INADEQUATE techniques.

#### V. Mass Spectrometry:

Introduction, ion production . Factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds. Common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule. High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

#### VI. Structural problems based on UV, IR, $^1\text{H}$ NMR, $^{13}\text{C}$ NMR spectroscopy and mass spectrometry.

### BOOKS SUGGESTED

1. Physical Methods for Chemistry. R.S. Drago, Saunders Company.
2. An Introduction to Practical Infrsred Spectroscopy, A.D.Cross and R.A. Jones., Butterworths, London.
3. Infrsred Spectroscopy, W.O.George and P.S.McIntyre., Wiley, Chichester.
4. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Horwood.
5. Practical NMR Spectroscopy. M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
6. Spectrometric Identification of Organic Compounds. RM. Silverstein. G.C. Bassler and T.C. Morill. John Wiley.
7. Introduction to NMR Spectroscopy. R.J. Abraham. J. Fisher and P.Loftus. Wiley.
8. Application of Spectroscopy of Organic Compounds. J.R. Dyer Prentice Hall.
9. Spectoscopic Methods in Organic Chemistry. D.H. Williams. Fleming. Tata Mc Graw-Hill.
10. Introduction to Mass Spectrometry, H.C. Hill.,Heyden, London.
11. Mass Spectrometry, R.Davis and M. Frearson., Wiley,, Chichester.
12. Interpretation of Mass Spectra, F.W.McLafferty., Benjamin.
13. Mass Spectrometry: Techniques and Applications, G.W.A.Milne., Wiley-Interscience, Newyork.



## SEMESTER-III

### Paper Second(Core)

## MOLECULAR REARRANGEMENTS AND PHOTOCHEMISTRY

### Molecular Rearrangements:

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

#### I. Migration to electron deficient carbon atom:

Pinacol-Pinacolone rearrangement, Wagner-Meerwein rearrangement, Tiffenev-Demjanov ring expansion, Dienone-Phenol rearrangement, Benzil Benzilic acid rearrangement, Arndt-Eistert synthesis, Favorski rearrangement.

#### II. Migration to electron deficient nitrogen atom:

Wolf, Hofmann, Curtius, Losen, Schmidt and Beckmann rearrangements.

#### III. Migration to electron deficient oxygen atom:

Baeyer-Villiger rearrangement.

### I. Photochemical Reactions:

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

#### II. Photochemistry of Alkene:

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

#### III. Photochemistry of Aromatic Compounds:

Isomerisations, additions and substitutions.

#### IV. Photochemistry of Carbonyl Compounds: -

Cleavage, - cleavages and inter and intra molecular hydrogen abstractions of carbonyl. Intermolecular reactions of carbonyl compounds-saturated, cyclic and acyclic. unsaturated compounds, rearrangements of cyclohexanone and rearrangement of unsaturated ketones, cyclohexadienones, intermolecular cycloaddition reactions-dimerisations and oxetane formation. Norrish type-I and type-II reactions.

#### V. Miscellaneous Photochemical Reactions:

Photo-Fries reactions of annelids, Photo-Fries rearrangement, Barton reaction, Singlet molecular oxygen and its reactions, photochemical formation of smog, photo-degradation of polymers. Chemistry of vision.

### BOOKS SUGGESTED

1. Fundamentals of Photochemistry. K.K. Rohtagi Mukherji, Wiley Eastern.
2. Essentials of Molecular Photochemistry A.Gilbert, Baggot Blackwell Scientific Publication.
3. Introductory Photochemistry. A. Cox and T. Camp. McGraw Hill.
4. Photochemistry. R.P. Kundall and A.Gilbert. Thomson Nelson.
5. Organic Photochemistry. J. Coxon and B.Halton. Cambridge University Press.
6. Frontier Orbitals and Organic Chemical Reactions, I. Fleming., Wiley, London.
7. Guide book to Mechanism in Organic Chemistry, P.Sykes., Longman, harlow.
8. Molecular Rearrangements in Organic synthesis by Christian M.Rojas, Wiley-VCH
9. Molecular Rearrangements by A.C. Knipe and J.M.Coxon, Wiley-VCH.



**SEMESTER III**  
**Paper Third(Core)**

**ANALYTICAL CHEMISTRY**

- I. **Introduction:** Role of analytical chemistry. Classification of analytical methods-classical and instrumental. Types of instrumental analysis. Neatness and cleanliness. Laboratory operations and practices, analytical balance. Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analytical laboratory.
- II. **Food Analysis:** Analysis of moisture, ash, crude protein, fat, crude fibre, carbohydrates, calcium, potassium, sodium and phosphate in food products. Food adulteration-common adulterants in food, contamination of food stuffs. Microscopic examination of foods for adulterants. Pesticide analysis in food products. Extraction and purification of sample. HPLC, Gas chromatography for organophosphates. Thin-layer chromatography for identification of chlorinated pesticides in food products.
- III. **Analysis of Water Pollution:** Origin of waste water, types water pollutants and effects. Sources of water pollution –domestic, industrial and agricultural . Soil and radioactive wastes as sources of pollution. Parameters for analysis -colour, turbidity total solids conductivity, hardness, chloride, sulphate. Metal/heavy metal pollution due to cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. Measurements of DO, BOD and COD. Pesticides as water pollutants and analysis Water pollution laws and standards.
- IV. **Analysis of Soil:** Moisture, pH, total nitrogen, phosphorus, silican, lime, magnesia, manganese, sulphur and alkali salts.
- IV. **Analysis of Drug:** Narcotics and dangerous drugs. Classification of drugs. Screening by gas and thin-layer chromatography and (spectrophotometric) measurements.

### BOOKS SUGGESTED

1. Analytical Chemistry, G.D. Christian, J.Wiley.
2. Fundamentals of Analytical Chemistry D.A. Skoog D.M. West and F.J. Holler W.B. Saunders.
3. Analytical Chemistry-Principles J.S. Kennedy, W.B. Saunders.
4. Analytical Chemistry-Principles and Techniques. L.G. Hargis Prentice Hall.
5. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary. W.B. Saunders.
6. Principles of Instrumental Analysis. D.A. Skoog. W.B. Saunders.
7. Quantitative Analysis, R.A. Day. Jr. and A.L. Underwood Prentice Hall.
8. Environmental Solution Analysis, S.M. Khopkar. Wiley Eastern.
9. Basic Concepts of Analytical Chemistry. S.M. Khopkar Wiley Eastern.
10. Handbook of Instrumental Techniques for Analytical Chemistry. F.Settle. Prentice Hall.



### **SEMESTER-III**

#### **Paper Fourth (Third Elective)**

#### **NANO MATERIALS AND SOLID STATE CHEMISTRY**

1. **Nano-materials:** Introduction and classification, Preparation and characterization of different types of nano structures-nanoparticles, nano clustures, nanowires, nanorods, nanofilms, nanotubes.
2. **Nano-catalysts:** Mode of action of catalysts, classification and comparison of nano-catalysis with homogeneous and heterogeneous catalysts. Specificity, shapes, surface area of nano-catalysts. Role of size, shape and surface area of nanoparticles in catalysts. Langmuir Hinshelwood mechanism on nano-catalysts.
3. **Liquid crystals:** Types of liquid crystals, Nematic, Smectic, ferroelectric and antiferro electric liquid crystals. Theories of LCs, liquid crystal display. New materials as liquid crystals.
4. **Solid State Reactions:** General principle, experimental procedure. Co-precipitation as a precursor to solid state reactions. Kinetics of solid state reactions.
5. **Organic Solids:** Electrically conducting solids, organic charge transfer complexes, organic metals, new superconductors.
6. **Crystal Defects and Non-Stoichiometry :** Perfect and imperfect crystals, intrinsic & extrinsic defects - point defects, line and plane defects, vacancies - Schottky defects & Frenkel defects.

#### **BOOKS SUGGESTED**

1. Solid State Chemistry and its Applications A.R. West, Plenum.
2. Principles of the Solid State H.V. Keer Wiley Eastern.
3. Solid State Chemistry, N.B. Hannay.
4. Solid State Chemistry D.K. Chakrabarty, New Age international.
5. Principles of the Solid State, H.V. Keer. Wiley Eastern.
6. Thermotropic Liquid Crystallism Ed. G.W. Gray. John Wiley.
7. Handbook of Liquid Crystals. Kelker and Hafz. Chemie Verlag.
8. Nanomaterials, Dieter Vollath, 2<sup>nd</sup> Edition, Wiley, VCH.
9. Nanomaterials: Science and Applications, Deborah Kane, Adam Micolich and Peter, Roger., CRC Press Books.

**SEMESTER-III**  
**Paper Fourth**  
**(Third Elective)**  
**INORGANIC SPECTROSCOPY**

- I. Electronic Spectroscopy:**  
Electronic spectral studies for  $d^1$ -  $d^9$  systems in octahedral, tetrahedral and square planer complexes,
- II. Vibrational Spectroscopy**  
Symmetry and shapes of  $AB_2$ ,  $AB_3$ ,  $AB_4$ ,  $AB_5$  and  $AB_6$ . Mode of bonding of ambidentate ligands, nitrosyl, ethylenediamine and diketonato complexes. Application of resonance. Raman spectroscopy and its applications.
- III. Electron Spin Resonance Spectroscopy:**  
Hyperfine coupling, 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  $PH_4$ ,  $F_2$  and  $[BH_3]$ .
- IV. Nuclear Magnetic Resonance Spectroscopy-I (Paramagnetic Substances in Solution):**  
The contact and pseudo contact shift, factors affecting nuclear relaxation, some applications including biochemical systems, an overview of NMR of metal nucleides with emphasis on  $^{195}P$  and  $^{119}Sn$  NMR.
- V. Nuclear Magnetic Resonance Spectroscopy - II**  
Chemical exchange, effect of deuteration, complex spin - spin interaction between two, three, four and five nuclei ( $1^{st}$  order spectra), stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with disordered angle, NMR shift reagents, solvent effects, Nuclear Overhauser effect (NOE).
- VI. Mossbauer Spectroscopy**  
Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of  $Fe^{+2}$  and  $Fe^{+3}$  compounds including those of intermediate spin, (2)  $Sn^{+2}$  and  $Sn^{+4}$  compounds: nature of M-L bond, coordination number, structure and (3) detection of oxidation state and in equivalent MB atoms.



## BOOKS SUGGESTED

1. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, Rankin and Cradock-ELBS.
2. Infrared and Raman Spectra Inorganic and Coordination compounds. K. Nakamoto. Willey.
3. Progress in Inorganic Chemistry vol. 8cd. F.A. Cotton. vol. 15 ed S.J. Lippard. Wiley.
4. Transition Metal Chemistry ed R.L. Carlin vol. 3 Dekker.
5. Inorganic Electronic Spectroscopy,. A.P.B. Lever. Elsevier.

## SEMESTER IV

### Paper First(Core)

## ORGANOMETALLIC CHEMISTRY

- I. Organometallic Compounds of transition elements:**  
General introduction of ligands, classification and nomenclature. 2-6 electron donor ligands with special reference to  $\pi$ -allyl, cyclopentadienyl and arenes.
- II. Synthesis, structure and bonding aspects of organometallic compounds with:**
- (a)  $\sigma$ -bonded alkyl groups as ligands. ( $\beta$ -Hydride elimination,  $\sigma$ -bonded  $\eta^1$ -aryl ligands)
  - (b) Olefinic and acetylic groups as ligands.
  - (c) Cyclic and acyclic polyenyl  $\pi$ -bonded ligands: ( $\pi$ -allyl, butadiene cyclobutadiene, cyclopentadienyl and arenes as ligands)
- III. Reactions in Organometallic Chemistry:**  
Oxidative addition, Oxidative coupling, Reductive elimination, Migratory insertion reactions, Coupling reactions (Palladium catalysed C-C and C-N couplings, Stille coupling, Heck coupling, Suzuki-Miyaura coupling, Sonogashira coupling, Negishi coupling, Hiyama coupling)
- IV. Homogeneous and heterogeneous transition metal catalysis:**  
General considerations, Reason for selecting transition metals in catalysis (bonding ability, ligand effects, variability of oxidation state and coordination number), Homogeneous hydrogenation of unsaturated compounds (alkenes, alkynes, aldehydes and ketones). Asymmetric hydrogenation. Phase transfer catalysis.
- V. Some important homogeneous and heterogeneous catalytic reactions:**  
Ziegler Natta polymerization of ethylene and propylene, oligomerisation of alkenes by aluminium alkyl, Wackers acetaldehyde synthesis, hydroformylation of unsaturated compounds using cobalt and rhodium complexes, Monsanto acetic acid synthesis, carboxylation reactions of alkenes and alkynes using nickel carbonyl and palladium complexes. Carbonylation of alkynes (acetylene) using nickel carbonyls or Palladium complexes.
- VI. Metal-metal bonding in carbonyl and halide clusters:**  
Polyhedral model of metal clusters, effect of electronic configuration and coordination number. Structures of metal carbonyl clusters of three atoms  $M_3(CO)_4$  ( $M = Fe, Ru \& Os$ ), Four metal atoms (tetrahedra)  $[M_4(CO)_4]^{2-}$  ( $M = Co, Rh \& Ir$ ) and octahedron of type  $M_6(CO)_6$  ( $M = Co \& Rh$ ), and halide derivatives of Rhenium (III) triangles, metal carbonyls involving bridged- terminal exchange and scrambling of CO group.  
**Metal Carbonyls and Nitrosyl:** Classification, bonding, factors affecting the magnitude of stretching frequency, Synthesis of metal carbonyls, Fluxionality, properties and reactions.  
**Fluxional Organometallic Compounds:** Fluxionality and dynamic equilibrium in compounds such as  $\eta^2$  olefine,  $\eta^3$ -allyl and dienyl complexes.
- V. Transition Metal-Carbon multiple bonded compounds:**  
Metal carbenes and carbynes (preparation, reactions, structure and bonding considerations). Biological applications and environmental aspects of organometallic compounds, Organometallic compounds in medicine, agriculture and industry.



### BOOKS SUGGESTED –

1. Principles and application of Organotransition Metal Chemistry J.P. Collman. L.S. Hedges. J.R. Norton and R.G. Finke University Science Books.
2. The Organometallic Chemistry, of the Transition Metals, R.H. Crabtree, John Wiley.
3. Metallo-organic Chemistry. A.J. Pearson Wiley.
4. Organometallic Chemistry, R.C. Mehrotra and A. Singh New Age International.
5. Organotransition Metal Chemistry, S.G. Davies., Pergamon Press Oxford.
6. Organometallics in Organic Synthesis, E.I. Negishi., Wiley, NewYork.

**SEMESTER -IV**  
**Paper Second(Core)**

**SOME SPECIFIC REACTIONS AND REAGENTS IN CHEMISTRY**

**I. Some Name Reactions:**

Bamford-Stevens reaction, Chichibabin reaction, Cope elimination reaction, Dakin oxidation, Mannich reaction, Meerwein-Ponndorf-Verley reduction, Mitsunobu reaction, Nef reaction, Oppenauer oxidation, Perkin reaction, Peterson olefination, Reformatsky reaction, Robinson annulations, Favorskii reaction, Birch reduction, Knoevenagel condensation, Stork- enamine reaction, Stetter reaction, Baylis-Hillman reaction and Wittig reaction.

**II. Reagents in Organic Synthesis:**

Use of following reagents in organic synthesis and functional group transformation.

- A.** Organometallic reagents –Organolithium reagents, Organomagnesium reagents, Organotitanium reagents, Organozinc, reagents, Organoboron reagents, Organosilicon reagents, Palladium-catalyzed Coupling Reactions.
- B.** DEAD, Tabbe's reagent, Hydrazine and phenylhydrazine, DCC, DDQ, Nucleophilic heterocyclic carbenes, 1, 3- Dithiane (Umpolung reactivity), Lithium diisopropyl amide (LDA), Selenium dioxide
- C.** Complex metal hydrides-  $\text{NaBH}_4$ ,  $\text{LiAlH}_4$ , DIBAL, diborane, disoamylborane, tetrylborane, 9-BBN, and isopinocampheylborane.

**III. Organic Reagents in Inorganic Chemistry:**

Chelation, factors determining the stability of chelates (effect of ring size, oxidation state of the metal, coordination number of the metal); Use of the following reagents in analysis:

- (a) Dimethylglyoxime (in analytical chemistry)
- (b) EDTA (in analytical chemistry and chemotherapy)
- (c) 8-Hydroxyquinoline (in analytical chemistry and chemotherapy)
- (d) 1,10-Phenanthroline (in analytical chemistry and chemotherapy)



## BOOKS SUGGESTED

1. Reagents for Organic Chemistry, L.F. Fieser and M. Fieser., Wiley, New York.
2. Organometallic Chemistry, R.C. Mehrotra and A. Singh., Wiley, Eastern.
3. Organotransition Metal Chemistry, S.G. Davies, Pergamon Press, Oxford.
4. Modern Synthetic Reactions, H.O. House, W.A. Benjamin, California.
5. Organic Chemistry, vol. I and II, I.L. Finar, Longman.
6. Comprehensive Organic Chemistry, D. Barton and W D Wallis., Pergamon Press, Oxford.
7. Advanced Organic Chemistry-Reaction Mechanism & Structure. Jerry March., John Wiley.
8. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg., Plenum.
9. A Guide book to Mechanism in Organic Chemistry, Peter Sykes., Longman.
10. Structure and Mechanism of Organic Chemistry, C.K. Ingold., Cornell University Press.

**SEMESTER- IV**  
**Paper Fourth**  
**(Fourth Elective)**

**CHEMISTRY OF NATURAL PRODUCTS**

**I. Terpenoids and Carotenoids:**

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Stereochemistry and synthesis of the following representative molecules:  $\alpha$ -Terpineol, camphor and Farnesol . Biogenesis of Terpenoids & alkaloids.

**II. 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 of the following: Ephedrine, Nicotine and Morphine.

**III. Steroids**

Occurrence, isolation and nomenclature. Diel's hydrocarbon. Basic skeleton and biological significance of sterols, bile acids, estrone, progesterone, aldosterone and testosterone. Photoproducts of ergosterol-vitamin D. Structure determination of cholesterol.

**IV. Prostaglandins**

Occurrence, nomenclature, classification, and physiological effects. Syntheses of PGE<sub>2</sub> and PGF<sub>2a</sub>.

**V. Anthocyanins:**

Methods of isolation, basic structural features of coumarins, flavones, chromones and isoflavones. Structural elucidation of quercetin .



### 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. Stereoselective Synthesis: A Practical Approach, M. Nogradi, VCH.
4. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
5. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed Kurt hostettmann, M.P. Gupta and A. Marston, Harwood Academic Publishers.
6. Introduction of Flavonoids, B.A. Bohm, Harwood Academic Publishers.
7. New Trends in Natural Product Chemistry, Atta-ur-Rahaman and M.I. Choudhary, Harwood Academic Publishers.
8. Insecticides of Natural Origin, Sukh Dev, Harwood Academic Publishers.
9. Organic Chemistry, Vol.II, I.L. Finar, Longman.

**SEMESTER -IV**  
**Paper Fourth**  
**(Fourth Elective)**  
**MEDICINAL CHEMISTRY**

**I. Drug Design**

Development of new drugs, procedures followed in drug design, concept of lead compound and end modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAR). Factors affecting bioactivity: Theories of drugs activity- occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drugs receptors and drug receptors. Elementary treatment of drug interactions. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton surface activity parameter and redox potentials. LD-50, ED-50 (Mathematical derivations of equations excluded). Basic ideas about Pharmacokinetics and Pharmacodynamics.

**II. Antineoplastic Agents**

Introduction, cancer chemotherapy. Role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors. Synthesis of mechlorethamine, mustards and 6- mercaptopurine. Recent developments in cancer chemotherapy.

**III. Cardiovascular Drugs**

Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function. Central intervention of cardiovascular output. Direct acting arteriolar dilators. Synthesis of amyl nitrate, hydralazine, methyldopa and diazoxide propanol.

**IV. Local Anti-infective Drugs**

Anti-tubercular drugs and Anti-malarial drugs: Introduction and general mode of action. Synthesis of sulphonamides, norfloxacin, dapson, chloroquin and primaquin.

**V. Psychoactive Drugs-The Chemotherapy of mind**

CNS depressants, general anesthetics, mode of action, hypnotics, sedatives, anti-anxiety drugs, benzodiazepines, antipsychotic drugs. Synthesis of diazepam, alprazolam and barbiturates.

**VI. Antibiotics**

General introduction, structure and synthesis of penicillin G & chloramphenicol.

**VI. Metals in Medicines**

Metal deficiency and diseases, toxic effects of metals, metals for diagnosis and chemotherapy.



### BOOKS SUGGESTED

1. Introduction to Medicinal Chemistry: How Drugs Act and Why?, A. Gringuaz., John Wiley and Sons.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry. Ed. Robert F. Dorge
3. An Introduction to Drug Design, S.S. Pandey and J.R. Dimmock, New Age International.
4. Burger's Medicinal Chemistry and Drug Discovery, Vol-1 (Chapter-9 and Ch-14) Ed. M.E. Wolff, John Wiley.
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
6. The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press.
7. Strategies for Organic Drug Synthesis and Design. D. Lednicer, John Wiley.
8. Organic Chemistry Vol.II, I.L. Finar., Longman.
9. Inorganic Biochemistry vol.I and II, G.L. Eichborn., Elsevier.

**M.Sc. CHEMISTRY PRACTICAL/DISSERTATION/RESEARCH PROJECT**



**SEMESTER - I**  
**CHEMISTRY PRACTICAL**  
**(First Practical)**  
**Inorganic :**

**a) Qualitative Analysis :**

Qualitative mixture analysis for seven radicals including two rare elements (Mo, W, Ti, Zr, Th, Ce, V) in cationic and anionic forms.

**b) Quantitative separation and determination of the following pairs of metal ions using gravimetric & volumetric methods.**

(i)  $\text{Ni}^{++}$  and  $\text{Cu}^{++}$

(ii)  $\text{Cu}^{++}$  and  $\text{Zn}^{++}$

(iii)  $\text{Ag}^+$  and  $\text{Cu}^{++}$

(iv)  $\text{Ag}^+$  and  $\text{Ca}^{++}$

**Organic**

**a) Separation and identification of organic compounds using chemical methods from binary mixture.**

**b) Isolation of**

(i) Caffeine from tea leaves

(ii) Eugenol from cloves

(iii) Casein from milk

(iv) Lycopene from Tomatoes

**Physical**

**Chemical Kinetics :**

1. Kinetic studies of a reaction between acetone and iodine catalyzed by  $\text{H}^+$  ions.
2. Kinetics of oxidation of reducing sugars by potassium ferricyanide in presence of ammonium hydroxide or sodium hydroxide.
3. Determination of rate constant and order of reaction between  $\text{H}_2\text{O}_2$  and HI
4. Determination of velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
5. Determination of the effect of a) change of temperature, b) ionic strength of media, c) change of concentration of reactants and catalysts on the velocity constant of hydrolysis of an ester/ionic reaction.

**Thermodynamics**

1. Determination of partial molar volume of solute (e.g. KCl) and solvent in a binary mixture.
2. Determination of the temperature dependence of the solubility of a compound in two solvents having similar inter molecular interactions and to calculate the partial molar heat of solution.

**SEMESTER - II  
CHEMISTRY PRACTICAL  
(Second Practical)**

**Inorganic :**

- A. Preparation of coordination complexes and their characterization by recorded UV, visible, IR spectra, molar conductivity measurement values etc.
- (a) VO (acac)<sub>2</sub>
  - (b) K<sub>3</sub> [Cr(C<sub>2</sub>O<sub>4</sub>)<sub>3</sub>] · 3H<sub>2</sub>O
  - (c) K<sub>3</sub> [Fe(C<sub>2</sub>O<sub>4</sub>)<sub>3</sub>]
  - (d) [Ni (NH<sub>3</sub>)<sub>6</sub>]Cl<sub>2</sub>
  - (e) [Cu(NH<sub>3</sub>)<sub>4</sub>] · SO<sub>4</sub> · 6.H<sub>2</sub>O
  - (f) Cis and trans copper glycimates.
- B. Paper chromatography separation of a mixture of the following and measurement of R<sub>f</sub> values.
- (a) Pb<sup>++</sup>, Ag<sup>+</sup>, Hg<sup>++</sup>
  - (b) Co<sup>++</sup>, Ni<sup>++</sup>, Cu<sup>++</sup>
  - (c) Ba<sup>++</sup>, Ca<sup>++</sup>, Sr<sup>++</sup>

**Organic**

- A. Preparation of various organic compounds involving two or three steps :
- (a) Dibenzal acetone from benzaldehyde
  - (b) Adipic acid by chromic acid oxidation of cyclohexanol.
  - (c) p-chlorotouene from p-toluidine
  - (d) Benzilic acid from benzoin
  - (e) m-nitro aniline from acetanilide
  - (f) Anthranilic acid from phthalic anhydride
- B. Quantitative estimation:
- (i) Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method.
  - (ii) Determination of iodine number & saponification values of an oil sample.
  - (iii) Estimation of amine/phenols using bromate bromide solutions or acetylation method.
  - (v) Estimation of carbonyl groups
  - (vi) Estimation of glycine (Sorensen's method)

**Physical**

**Electrochemistry conductometry :**

- (a) Determination of the velocity constant, order of reaction and energy of activation for



saponification of ethyl acetate by sodium hydroxide conductometrically.

- (b) Determination of strength of strong and weak acids in a given mixture conductometrically.
- (c) Determination of solubility and solubility product of sparingly soluble salts (eg  $\text{PbSO}_4$ ,  $\text{BaSO}_4$ ) conductometrically.
- (d) Estimation of glucose by conductometric method

**Potentiometry/ PH metry**

- (a) Determination of strength of halides in a mixture potentiometrically.
- (b) Determination of strength of strong and weak acids in a given mixture using potentiometer/pH meter.
- (c) Acid-Base titration in non-aqueous media using pH meter.
- (d) Determination of temperature dependence of EMF of a cell.

**SEMESTER - III**  
**CHEMISTRY PRACTICAL**  
**(Third Practical)**

**Any four experiments selecting at least one from each section**

**Section - I**

- (i) Ion exchange method of separation :  
Separation of  $Zn^{++}$  and  $Mg^{++}$  on an ion exchanger.  
Separation of  $Co^{++}$  &  $Ni^{++}$  on an ion exchanger.
- (ii) Spectrophotometric determinations:  
Iron-phenanthroline complex : Job's Method  
Manganese / chromium / vanadium in steel / water sample.
- (iii) Thin layer chromatographic separation of cations like  $Ni^{++}$ ,  $Mn^{++}$ ,  $Co^{++}$  &  $Zn^{++}$  etc. and determination of their  $R_f$  values.

**Section - II**

- (i) Separation & identification of organic compounds using chemical methods from organic mixtures containing upto three components.
- (ii) Paper chromatography : Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography & determination of  $R_f$  values.

**Section - III**

- (i) Verification of Lambert-Beer's law and to determine concentration of unknown sample.
- (ii) Flame emission photometric determination of ions e.g. sodium potassium etc.
- (iii) Polarimetric determination of rate constant for hydrolysis/inversion of sugar.
- (iv) Polarimetric study of Enzyme kinetics-inversion of sucrose.





**SEMESTER - IV**  
**CHEMISTRY PRACTICAL**

**Research Project/Dissertation**

### BOOKS SUGGESTED –

1. Inorganic Experiments. J. Derek Wooline VCH
2. Microscale Inorganic Chemistry, Z Szafrsn R.M. Pike, M.M. Singh. Wiley.
3. Practical Inorganic Chemistry, G. Mar and B.W. Bookett. Van Nostrand.
4. The Systematic Identification of Organic Compounds R.L. Shnier and D.Y. Curtn.
5. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J.B. Entnkin and E.M. Hodentt.
6. Experimental Organic Chemistry, M.P. Doyte and W.S. Mungall.
7. Small Scall Scale Organic Preparations, P.J. Hilli
8. Organometallic Synthesis, J.J. Fisch and R.B. King Academic Press.
9. Experimental Physical Chemistry. D.P. Shoemaker, C.W. Garland and J.W. Niber, McGraw, Hill Interscience.
10. Findlay's Practical Physical Chemistry, revised B.P. Lew Longman.
11. Experiments in Physical Chemistry, J.C. Ghose, Bharat Bhavan.
12. Vogel's Taxtbook of Quantitative Analysis.. Revised, J.Bas set R.C. Denney. G.H. Jeffery and J. Mendham, ELBS.
13. Synthesis and Charaterisation of inorganic compunds-W.L. Jolly, Prentice Hall.
14. Experiments and Techniques in Organic Chemistry-D Pasto, C. Johnson and M. Miller-Prentice Hall.
15. Systematic Qualitative Organic Analysis-H Middleton, Edward Arnold.
16. Handbook of Organic Analysis-H. Middleton, Edward Arnold.
17. Vogels Texbook of Practical Organic Chemistry –A.R. Tatchell, John Wiley.
18. Practical Physical Chemistry – A.M. James and F.E. Prichard.
19. Findley's Practical Physical Chemistry-S.P. Levitt, Longman.
20. Experimental Physical Chemistry-R.C. Das and B. Behera, Tata McGraw Hill.