SYLLABUS

M. Sc. CHEMISTRY

SEMESTER EXAMINATION

2018-2020
EXAMINATION SCHEME
M.Sc. examination will be conducted in four SEMESTERS. Each semester exam shall consist of FOUR THEORY PAPERS AND TWO LAB COURSES.

SEMESTER – I (20 CREDIT)

<table>
<thead>
<tr>
<th>PAPER</th>
<th>COURSE</th>
<th>CREDIT</th>
<th>DURATION</th>
<th>INTERNAL ASSESSMENT</th>
<th>THEORY MARKS</th>
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<tbody>
<tr>
<td>CH - 1</td>
<td>GROUP THEORY AND CHEMISTRY OF METAL COMPLEXES</td>
<td>4</td>
<td>3 Hrs</td>
<td>20</td>
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<tr>
<td>CH - 2</td>
<td>CONCEPTS IN ORGANIC CHEMISTRY</td>
<td>4</td>
<td>3 Hrs</td>
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<td>CH - 3</td>
<td>QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - I</td>
<td>4</td>
<td>3 Hrs</td>
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<td>CH - 4</td>
<td>THEORY AND APPLICATIONS OF SPECTROSCOPY-I</td>
<td>4</td>
<td>3 Hrs</td>
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PRACTICAL (4 CREDIT)

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<tr>
<td>CH - 5</td>
<td>Lab Course – I</td>
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<td>CH - 6</td>
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SEMESTER – II (20 CREDIT)

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<td>TRANSITION METAL COMPLEXES</td>
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<td>CH - 8</td>
<td>REACTION MECHANISMS</td>
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<td>CH - 9</td>
<td>QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - II</td>
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<td>CH - 10</td>
<td>THEORY AND APPLICATIONS OF SPECTROSCOPY-II</td>
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## Practical (4 Credit)

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<td>CH - 12</td>
<td>Lab Course – IV</td>
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## Semester – III (20 Credit)

### Theory (16 Credit)

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<td>CH – 13</td>
<td>RESONANCE SPECTROSCOPY PHOTOCHEMISTRY AND ORGANOCATALYSIS</td>
<td>4</td>
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<td>CH – 14</td>
<td>CHEMISTRY OF BIOMOLECULES</td>
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<td>CH – 15</td>
<td>CATALYSIS, SOLID STATE AND SURFACE CHEMISTRY</td>
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<td>CH – 16</td>
<td>ANALYTICAL TECHNIQUES AND DATA ANALYSIS</td>
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<td>CH – 18</td>
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### SEMESTER –IV (20 CREDIT)

#### THEORY (16 CREDIT)

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<tr>
<td>CH – 19</td>
<td>INSTRUMENTAL METHODS OF ANALYSIS</td>
<td>4</td>
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<td>CH – 20</td>
<td>NATURAL PRODUCT AND MEDICINAL CHEMISTRY</td>
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<td>MATERIAL AND CHEMISTRY NUCLEAR</td>
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<td>CH - 22</td>
<td>ENVIRONMENTAL &amp; APPLIED CHEMICAL ANALYSIS</td>
<td>4</td>
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#### OPTIONAL PAPERS

In place of CH 22 students can opt any optional papers CH 22a to CH 22c

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<td>CHEMISTRY OF SURFACTANTS</td>
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<td>NANO CHEMISTRY</td>
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<td>CH 22 c</td>
<td>POLYMERS</td>
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<td>CH - 24</td>
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### SCHEME FOR PRACTICAL EXAMINATION

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<th>EXPERIMENT</th>
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<tr>
<td>Experiment-1</td>
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<td>Experiment -2</td>
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<td>Viva-voce</td>
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FIRST SEMESTER
PAPER NO. CH–1
GROUP THEORY AND CHEMISTRY OF METAL COMPLEXES
Max. Marks 80

UNIT - I
SYMMETRY AND GROUP THEORY IN CHEMISTRY: Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup. Contumacy relation and classes. Point symmetry group. Schoenflies 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 of $C_{2v}$, $C_{2h}$, $C_{3v}$ and their use in spectroscopy.

UNIT - II
A. METAL-LIGAND BONDING: Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes. π bonding and molecular orbital theory.
B. METAL-COMPLEXES: Metal carbynols, structure and bonding, vibrational spectra of metal carbynols for bonding and structural elucidation, important reactions of metal carbynols; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.

UNIT – III
A. METAL–LIGAND EQUILIBRA IN SOLUTION: Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH- metry and spectrophotometry.
B. ISOPOLY ACID AND HETEROPOLYACID: Isopoly and heteropoly acids of Mo and W. Preparation, properties and structure. Classification, Preparation, properties and structures of borides, carbides, nitrides and silicide’s.
SILICATES- Classification and structure.
SILICONES- preparation, properties and application.

UNIT – IV
A. METAL CLUSTERS: Higher boranes, carboranes, metallo boranes and metallocarboranes.
B. CHAINS: Catenation, heterocatenation, intercatenation.
C. RINGS: Borazines, phosphazines.

BOOKS SUGGESTED:
2. Inorganic Chemistry, J.E. Huhey, Harpes and Row.
UNIT - I

A. NATURE OF BONDING IN ORGANIC MOLECULES: Localized and delocalized chemical bond, conjugation and cross-conjugation, Bonding in Fullerenes, Bonds weaker than covalent, Addition compounds, Crown ether complexes and cryptands. Inclusion compounds, Cyclodextrins, Catenanes and rotaxanes.

B. AROMATICITY: Aromaticity in benzonoid and non-benzenoid compounds, Huckel’s rule anti-aromaticity, homo-aromaticity. PMO approach for Aromatcity, Annulenes.

UNIT - II

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

B. STEREOCHEMISTRY: Elements of symmetry, chirality, molecules with more than one chiral center, methods of resolution, optical purity, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon (Biphenyls, allenes and spiranes), chirality due to helical shape.

UNIT - III

A. REACTION INTERMEDIATES: Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Sandmeyer reaction, Free radical rearrangement and Hunsdiecker reaction.

B. ELIMINATION REACTIONS: The E$_2$, E$_1$ and E$_{1c}$ B mechanisms. Orientation of the double bond. Reactivity, effects of substrate structures, attacking base, the leaving group and the medium.

UNIT - IV

PERICYCLIC REACTIONS: 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 - antrafacial and suprafacial additions, 4n and 4n+2 system, 2+2 addition of ketenes, 1, 3 dipolar cycloadditions and chelotropic reactions. 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. Ene reaction.

BOOKS SUGGESTED:
11. Rodd’s Chemistry of Carbon Compounds, Ed. S. Coff
UNIT - I

A. MATHEMATICAL CONCEPT IN QUANTUM CHEMISTRY:
Vector quantities and their properties. Complex numbers and Coordinate transformation. Differential and Integral Calculus, Basis rules of differentiation and Integration Applications.

B. The Schrödinger equation and postulates of quantum mechanics. Discussion of solutions of the Schrödinger equation to some model systems viz Particle in a box, the harmonic oscillator, the rigid rotator, the hydrogen atom.

UNIT –II

BASICS OF THERMODYNAMICS: Maxwell’s thermodynamic relations, isotherm, Vant’s Hoff hypothesis. Partial molar volume and partial molar heat content. Chemical potential, Gibbs-Duhem equation, variation of chemical potential with temperature and pressure. Chemical potential of ideal gases, pure solids, liquids and mixture of ideal gases. Activity and Fugacity, Determination of Fugacity, Variation of Fugacity with temperature and pressure.

UNIT –III


UNIT –IV

CHEMICAL DYNAMICS –I: Methods of determining rate laws, consecutive reactions, collision theory of reaction rates, steric factor, Activated complex theory, kinetic salt effects, steady state kinetics, and thermodynamic and Kinetic control of reactions. Dynamic chain (Hydrogen-bromine and Hydrogen-chlorine reactions) and Oscillatory reactions (Belousov-Zhabotinsky reaction).

BOOKS SUGGESTED:
4. Physical Chemistry, P.W. Atkins, ELBS.
5. Coulson’s Valence, R. McWeeny, ELBS.
9. Thermodynamics for Chemists, S. Glasstone, EWP.
10. An Introduction to Electrochemistry S. Glasstone, EWP.
UNIT - I

UNIFYING PRINCIPLES:
Electromagnetic radiation, interaction of electromagnetic radiation with matter- absorption, emission, transmission, reflection, dispersion, polarization and scattering. Uncertainty relation and natural line width and natural line broadening, transition probability, selection rules, intensity of spectral lines, Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels.

UNIT - II

MICROWAVE SPECTROSCOPY:
Classification of molecules in terms of their internal rotation mechanism, determination of rotation energy of diatomic and polyatomic molecules, effect of isotopic substitution on diatomic and polyatomic molecules. Intensities of rotational spectral lines and parameters of rotational and the transition frequencies, non-rigid rotors, Linear and symmetric top polyatomic molecules. Application in determination of bond length.

UNIT - III

SCATTERING SPECTROSCOPY:
B. Theory, instrumentation and application of turbidimetry, nephelometry and fluorometry, Fluorosence and phosphorescence and factors affecting them.

UNIT - IV

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), Instrumentation, Application of Raman effect in molecular structures, Raman activity of molecular vibration, structure of CO₂, N₂O, SO₂, NO₂, ClF₃.

BOOKS SUGGESTED
1. **QUALITATIVE ANALYSIS OF MIXTURE CONTAINING EIGHT RADICALS INCLUDING TWO LESS COMMON METAL FROM AMONG THE FOLLOWING BY SEMI MICROMETHOD.**

   1) **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.

   2) **Acid Radicals:**

2. **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.

3. **ESTIMATION OF:**
   1) Phosphoric acid in commercial orthophosphoric acid.
   2) Boric acid in borax.
   3) Ammonia in ammonium salt.
   4) Manganese dioxide in pyrolusite.
   5) Available chlorine in bleaching powder.
   6) Hydrogen peroxide in a commercial sample.

4. **PREPARATIONS:**
   Preparation of selected inorganic compound and their studies by I.R. electronic spectra, Mössbauer, E.S.R. And magnetic susceptibility measurements. Handling of air and moisture sensitive compounds
   - (1) VO(acac)2
   - (2) TiO(C9H8NO)2. 2H2O
   - (3) cis-K [Cr(C2O4)2(H2O)2]
   - (4) Na [Cr (NH3)2(SCN)4]
   - (5) Mn(acac)3
   - (6) K2[Fe(C2O4)3]
   - (7) Prussian Blue, Turnbull’s Blue.
   - (8) [Co (NH3)6] [Co(NO2)6]
   - (9) cis-[Co(trien) (NO2)2]Cl. H2O
   - (10) Hg [Co(SCN)4]
   - (11) [Co(Py)2Cl2]
   - (12) [Ni (NH3)6]Cl2
   - (13) Ni(DMG)2
   - (14) [Cu (NH3)4] SO4.H2O

**BOOKS SUGGESTED**

1. Vogel’s Textbook of Quantitative Analysis, Revi Mendham, ELBS.
**LABORATORY COURSE – II**

**Max. Marks 100**

**ADSORPTION/SURFACE CHEMISTRY**
1. To Study Surface tension-Concentration relationship for solutions (Gibbs equation).
2. To Verify the Freundlich and Langmuir Adsorption isotherms using acetic acid/oxalic acid and activated charcoal.
3. Determination of CMC of surfactants

**PHASE EQUILIBRIA**
1. To Construct the Phase diagram for three component system (e.g. chloroform-acetic acid-water).

**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 velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
3. Determination of the rate constant for the decomposition of hydrogen peroxide by Fe+++ and Cu++ ions.
4. Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion).

**SOLUTIONS/MOLECULAR WEIGHTS**
1. Determination of molecular weight of non-volatile substances by Lands berger method.
2. Determination of Molar masses of Naphthalene/acetanilide

**CONDUCTOMETRY**
1. Determination of the velocity constant, order of the reaction and energy of activation for hydrolysis of ethyl acetate by sodium hydroxide conductometrically.
2. Determination of solubility and solubility product of sparingly soluble salts (e.g., PbSO₄, BaSO₄) conductometrically.
3. Determination of pKₐ 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 the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.
3. Determination of the dissociation constant of monobasic/dibasic acid by Albert-Serjeant Method. Determination of Redox potential of Fe”+/Fe”++ system.

**POLARIMETRY**
1. Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.
2. Enzyme kinetics –inversion of sucrose.
3. Determine the specific and molecular rotation of optically active substances.

**BOOKS SUGGESTED**
5. Vogel’s Textbook of Practical Organic Chemistry,
7. Findley’s Practical Physical Chemistry, B.P.Levi
SECOND SEMESTER
PAPER NO. CH - 7
TRANSITION METAL COMPLEXES

Max. Marks 80

UNIT - I
REACTION MECHANISM OF TRANSITION METAL COMPLEXES: Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, anation reactions and reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, 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.

UNIT - II
ELECTRONIC SPECTRA AND MAGNETIC PROPERTIES OF TRANSITION METAL COMPLEXES:
Spectroscopic ground states, Correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), Selection rules, mechanism for breakdown of the selection rules, intensity of absorption, band width, spectra of d-d metal complexes of the type [M(H2O)6]^{n+}, spin free and spin paired ML6 complexes of other geometries, Calculations of Dq, B and parameters, spin forbidden transitions, effect of spin-orbit coupling, Spectrochemical and Nephelouxetic series. Magnetic properties of complexes of various geometries based on crystal field model, spin free-spin paired equilibrium in octahedral stereochemistry.

UNIT - III
A. TRANSITION METAL COMPLEXES: Transition metal complexes with unsaturated organic molecules, alkanes, allyl, dienedienyl, arene and trienyl complex, preparations, properties, nature of bonding and structure features. Important reaction relating to nucleophilic and electrophilic attack on ligands and organic synthesis.
B. Transition Metal, Compounds with Bond to hydrogen.

UNIT-IV
A. ALKYLs AND ARYLS OF TRANSITION METALS: Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.
B. COMPOUNDS OF TRANSITION METAL - CARBON MULTIPLE BONDS: Alkylidenes, low valent carbenes, nature of bond and Structural characteristics.
C. FLUXIONAL ORGANOMETALLIC COMPOUNDS: Fluxionality and dynamic equilibria in compounds such as olefin, allyl and dienyl complexes.

BOOKS SUGGESTED:
2. The Organometallic chemistry of the Transition metals, R.H.Crabtree, JohnWiley.
5. Principles of organometallic chemistry, P.Powel, Springer
UNIT-I

A. **ALIPHATIC NUCLEOPHILIC SUBSTITUTION**: The SN₂ and SN₁ mechanisms. The neighboring group mechanism, neighboring group participation by π and σ bonds, anchimeric assistance. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis, ambident nucleophile and regioselectivity.


UNIT - II

A. **ALIPHATIC ELECTROPHILIC SUBSTITUTION**: Mechanisms of SE₁, SE₂, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

B. **AROMATIC ELECTROPHILIC SUBSTITUTION**: The arenium ion mechanism, orientation and reactivity. The ortho/para ratio, ipso attack, orientation in other ring systems. Reactivity-Effect of substrates and electrophiles. Vilsmeier reaction and Gattermann-Koch reaction.

UNIT - III

**ADDITION TO CARBON-CARBON MULTIPLE BONDS**: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings Hydroboration, Micheal reaction. Sharpless asymmetric epoxidation.

UNIT - IV

**ADDITION TO CARBON-HETERO MULTIPLE BONDS**: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids esters and nitriles. Addition of Grignard Reagents, Organo-Zinc and Organo-lithium to carbonyls and unsaturated carbonyl compounds, Wittig reaction.


**BOOKS SUGGESTED:**

UNIT –I
A. **APPLICATION OF MATRICES IN QUANTUM CHEMISTRY**: Addition and multiplication, inverse and transpose of matrices. Determinants in Quantum Chemistry.

B. **ANGULAR MOMENTUM IN QUANTUM CHEMISTRY**: Angular momentum, angular momentum Operators. Eigen functions and Eigen values Angular momentum, Ladder operators.


UNIT –II

UNIT –III

UNIT –IV
**CHEMICAL DYNAMICS –II**: General features of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. Dynamics of molecular motions, probing the transition state, dynamics of barrier less chemical reactions in solutions, dynamics of unimolecular reaction. [Lindemann –Hinshel wood, RRK and Rice-Ramsperger-Kassel-Marcus {RRKM}] theories of unimolecular reactions.

**BOOKS SUGGESTED:**
7. Physical Chemistry, P.W. Atkins, ELBS.
10. Coulson’s Valence, R. McWeeny, ELBS.
14. Thermodynamics for Chemists, S. GlasstoneEWP.
15. An Introduction to Electrochemistry S. GlasstoneEWP.
17. Physical Chemistry, Silbey, Alberty, Bawendi, John-Wiley.
UNIT - I

ULTRAVIOLET AND VISIBLE SPECTROSCOPY:

UNIT - II

INFRA RED SPECTROSCOPY:
Introduction, simple and anharmonic oscillators in vibrational spectroscopy, diatomic-vibrating rotor, Modes of vibration in polyatomic molecules, vibration-coupling, Fourier Transform IR spectroscopy: instrumentation, interferometric spectrophotometer, sample handling, Factors influencing vibrational frequencies, Application of IR spectroscopy: Interpretation of IR spectra of normal alkanes, aromatic hydrocarbons, alcohols and phenols, aldehydes and ketones, ethers, esters, carboxylic acids, amines and amides.

UNIT - III

MASS SPECTROMETRY:
Introduction, basic principles, separation of the ions in the analyzer, resolution, molecular ion peak, mass spectral fragmentation of organic compounds, factors affecting fragmentation, McLafferty rearrangement. Instrumentation, Characteristics of mass spectra of Alkanes, Alkenes, Aromatic hydrocarbons, Alcohols, Amines. Nitrogen rule, ring rule, Molecular weight and formula determination.

UNIT - IV

NUCLEAR RESONANCE SPECTROPHOTOMETRY:
Theory of NMR spectroscopy, interaction of nuclear spin (and magnetic moment, chemical shift, processional motion of nuclear particles in magnetic field, spin-spin splitting, coupling constants, factor affecting the chemical shift, shielding effect, effect of chemical exchange, hydrogen bonding, instrumentation of Fourier transform NMR spectrophotometer, structure determination of organic compounds,
Carbon-13 NMR spectroscopy, Multiplicity-proton (¹H) decoupling-noise decoupling, off resonance decoupling, selective proton decoupling. Chemical shift (aliphatic, olefinic, alkyne, aromatic and carbonyl carbon)

BOOKS SUGGESTED
1. **GENERAL METHODS OF SEPARATION AND PURIFICATION OF ORGANIC COMPOUNDS WITH SPECIAL REFERENCE TO:**
   - Solvent Extraction
   - Fractional Crystallisation

2. **DISTILLATION TECHNIQUES:**
   - Simple distillation, steam distillation, Fractional distillation and distillation under reduced pressure.

3. **ANALYSIS OF ORGANIC BINARY MIXTURE:**
   - Separation and identification of organic binary mixtures containing at least one component with two substituents.
   (A student is expected to analyse at least 10 different binary mixtures.)

4. **PREPARATION OF ORGANIC COMPOUNDS: SINGLE STAGE PREPARATIONS.**
   1) **Acetylation:** Synthesis of β-Naphthyl acetate from β-Naphthol / Hydroquinone diacetate from Hydroquinone.
   2) **Aldol condensation:** Dibenzal acetone from benzaldehyde.
   3) **Bromination:** p-Bromoacetanilide from acetanilide.
   4) **Cannizzaro Reaction:** Benzoic acid and Benzyl alcohol from benzaldehyde.
   5) **Friedel Crafts Reaction:** O-Benzoyl Benzoic acid from phthalic anhydride.
   6) **Grignard Reaction:** Synthesis of triphenyl methanol from benzoic acid,
   7) **Oxidation:** Adipic acid by chromic acid oxidation of cyclohexanol.
   8) **Perkin’s Reaction:** Cinnamic acid from benzaldehyde.
   9) **Sandmeyer Reaction:** p-Chlorotoluene from p-toluidine/o-Chlorobenzoic acid from anthranilic acid.
   10) **Schotten Baumann Reaction:** β-Naphthyl benzoate from : β-Naphthol / Phenyl benzoate from phenol.
   11) **Sulphonation Reaction:** Sulphanilic acid from aniline.

**BOOK 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.
6. Practical Physical chemistry by Alexander Findlay.
8. Findlay’s Practical Physical chemistry, revisedB
I. ERROR ANALYSIS AND STATISTICAL DATA ANALYSIS
1. Linear Regression Analysis
2. Curve Fitting
3. Student “t” Test
4. Data Analysis Using Basic Statistical Parameters
5. Calibration of volumetric Apparatus, Burette, Pipette Weight Box etc.

II. USE OF COMPUTER PROGRAMMES

The students will learn how to operate a PC and how to run standard programmes and packages. Execution of linear regression, X-Y plot, numerical integration and differentiation as well as differential equation. solution programmes. Monte Carlo and Molecular dynamics. Programmes with data preferably from physical chemistry laboratory. Further, the student will operate one or two or the packages such as MICROSOFT EXCEL, WORD, POWERPOINT, SPSS, ORIGIN, MATLAB, EASYPLOT.

III. A. FLAME PHOTOMETRIC DETERMINATIONS
1. Sodium and Potassium when present together.
2. Sodium/Potassium in solid samples.
3. Solid Sodium and Potassium in Liquid Samples.
4. Lithium/Calcium/Barium/Strontium.
5. Cadmium and Magnesium in tap water.

B. NEPHELOMETRIC DETERMINATIONS
1. Sulphate
2. Phosphate
3. Silver

IV. ELECTROPHORESIS
1. To separate cations of inorganic salts by paper electrophoresis.
2. Capillary Electrophoresis of water soluble Vitamins.

V. SPECTROSCOPY
1. Verification of Beer’s Lambert Law.
2. Determination of stoichiometry and stability constant of inorganic (e.g. ferric –salicylic acid) and organic (e.g. amine-iodine) complexes, thiocynam.
3. Characterization of the complexes by electronic and IR, UV spectral data.
4. Determination of Indicator constant (pK_a) of methyl red.

BOOKS SUGGESTED:

2. Computational Chemistry, A.C.Norris.
THIRD SEMESTER
PAPER NO. CH - 13
RESONANCE SPECTROSCOPY, PHOTOCHEMISTRY AND ORGANO CATALYSIS
Max. Marks 80

UNIT –I
A. 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).
B. NUCLEAR QUADRUPOLE RESONANCE SPECTROSCOPY: Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant, splittings, applications.

UNIT –II
A. PHOTOELECTRON SPECTROSCOPY: Basic principle for atoms and molecules; Photo-electric effect, ionization process, Koopman’s theorem, Augerelectron spectroscopy, Determination of Dipole moment. Photoelectron spectra of simple molecules-ESCA.
B. PHOTOACOUSTIC SPECTROSCOPY: Basic principle of Photo acoustic Spectroscopy (PAS), PAS –gases and condensed system. Chemical and Surface applications.

UNIT –III
A. PHOTOCHEMICAL REACTIONS: Interaction of electromagnetic radiation with matter, Stern Volmer equation, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, Actinometry.
B. DETERMINATION OF REACTION MECHANISM: Classification, rate constants and life times of reactive energy states , determination of rate constants of reactions. Effect of light intensity on the rate of photo chemical reactions.

UNIT –IV
A. ORGANO CATALYSIS

BOOK SUGGESTED:
UNIT –I
A. **BIOENERGETICS:** Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.
B. **ELECTRON TRANSFER IN BIOLOGY:** Structure and function of metalloproteins in electron transport processes—cytochromes and ion-sulphur proteins, synthetic models.
C. **TRANSPORT AND STORAGE OF DIOXYGEN:** Heme proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, haemocyanins and haemerythrin, model synthetic complexes of iron, cobalt and copper.

UNIT –II
B. **ENZYME MODELS:** Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biomimetic chemistry, Cyclodextrin-based enzyme models, calixarenes, ionophores, synthetic enzymes or synzymes.

UNIT –III
A. **ENZYMES:** Nomenclature and classification of Enzyme. Induced fit hypothesis, concept and identification of active site by the use of inhibitors.
B. **CO-ENZYME CHEMISTRY:** Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic acid, vitamin B12.
C. **BIOTECHNOLOGICAL APPLICATIONS OF ENZYMES:** Techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilization enzymes in medicine and industry. Enzymes and Recombinant DNA Technology.

UNIT –IV
A. **BIOPOLYMER INTERACTIONS:** forces involved in biopolymer interaction. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions. Multiplequilibria and various types of binding processes in biological systems. Hydrogen ion titration curves.
B. **THERMODYNAMICS OF BIOPOLYMER SOLUTIONS:** Thermodynamics of biopolymer solution, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechnochemical system.
C. **CELL MEMBRANE AND TRANSPORT OF IONS:** Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport and Nerve conduction.
BOOKS SUGGESTED:

8. Understanding Enzymes, Trevor palmer, Prentice Hall.
22. Biochemistry and Molecular Biology of Plants, Buchanan, Gruissem and Jones, I.K. International Pvt. Ltd.
UNIT –I
ACIDS, BASES, ELECTROPHILES, NUCLEOPHILES AND CATALYSIS:

UNIT –II
MICELLES AND ADSORPTION:
Micelles: Classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of Surfactants. Thermodynamics of micellization - phase separation and mass action models. Reverse micells, micro-emulsion. Micellar Catalysis, Surface tension capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm.

UNIT –III
SOLID STATE CHEMISTRY - I:
Crystal defects and Non-stoichiometry - Perfect and imperfect crystals, intrinsic and extrinsic defects - point defect, line and plane defects, vacancies - Schottky defects and Frankel defects. Thermodynamics of Schottky and Frenkel defect, formation of color centres, non-stoichiometry and defects. Electronic properties and Band theory of semiconductors.

UNIT –IV
MACROMOLECULES:
Polymer – Definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization. Molecular 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.

BOOKS SUGGESTED:

UNIT – I
SAMPLE PREPARATION, DIGESTION AND STATISTICAL ANALYSIS
A. Sampling - Collection, Preservation and preparation of sample, Techniques of sampling solids, liquids and gases, Operation of drying and preparing a solution of the analyte. Principle, methodology and application of different types of digestions such as acid digestion, base digestion, enzymatic and microwave digestion for liquid and solid materials.
B. Evolution and procession of Analytical Data, Precision and Accuracy, Types of Errors, Propagation of errors, Normal Distribution Curve, Standard deviation, Confidence limit, Graphical presentation of result-METHOD of average, Method of Linear least square, Significant figures, Statistical aid to hypothesis testing-t-test, F-test, Correlation coefficient, Rejection of data.

UNIT – II
SEPARATION TECHNIQUES
A. Efficiency of extraction, Selectivity of extraction, Extraction system, Method of Extraction, applications.
B. Principle, classification of chromatographic techniques, Technique and applications of paper chromatography, Thin-layer chromatography, HPLC, Column chromatography. Gas Chromatography

UNIT – III
THERMAL AND AUTOMATED METHODS
A. Principle, Instrumentation, Application of TGA, DTA and DSC methods.
B. Automated methods, Principle, instrumentation and application off low injection analysis.

UNIT – IV
ELECTROCHEMISTRY
A. Principles and instrumentation of pHpotentiometry, coulometry and conductometry.
B. Basic principles, Diffusion current, polarized electrode, Micro electrode, Dropping Mercury Electrode, Ilkovic equation, Polarographic wave, Qualitative analysis Stripping methods, Cyclic Voltammetry, Amperometric titration:- curves, Differential pulse polarography and Squarewave polarography.

BOOK SUGGESTED :
1. Fundamental of Analytical Chemistry- Skoog D.A. and West D.M.
2. Saunders, College Publication.
3. Textbook of Quantitative Inorganic Analysis-Vogel A.I.
4. Principles and Practice of Analytical Chemistry-Fifield F. Wand Kealey
5. D. Black well Science
8. Instrumental Analysis, Willard Meritt Dean, CBS.
10. Fundamental of Analytical Chemistry-Skoog D.A. and WestD.M.
12. Instrumental Analysis, Wizard Dean and Merit.
1. Determination of the partition coefficient for iodine between carbon tetrachloride &
(a) Water,
(b) Aqueous potassium iodide.
2. Study of kinetics of exchange between ethyl iodide & the iodide ion.
3. Determination of the solubility product of lead iodide.
4. Determination of the dissociation constant of Barium Nitrate.
5. Determination of the concentration of iodine in a given sample (KI) by isotope
dilution technique.
6. To study the effect of temperature, concentration of the reactant and catalyst on
the rate of a chemical reaction (Hydrolysis/Nucleophilic Substitution).
7. To study Reaction between Sodium Formate and Iodine by
(i) Volumetric Method.
(ii) Conductometric Method.
8. Saponification of ethylacetate
(i) Volumetric Method.
(ii) Conductometric Method.
9. To study the reaction between Acetone and Iodine.
10. To study the autocatalytic reaction between KMnO₄ and Oxalic acid.
11. To study the reaction between K₂S₂O₈ and Iodine.
13. Evaluation of Equilibrium constants from kinetic data.
14. Determination of rate constant of the decomposition of benzene diazonium
chloride at different temperature.
15. To study the photolysis of uranyl oxalate.
16. To study the effect of substrate catalyst etc (i) HCl, K₂S₂O₈ (ii) KOH, NaOH.
17. To study the Activation parameters.
18. To study the solvent effect using some Aprotic & Protic Solvents.
19. To examine the substituent effect (Hammette quation).
20. To study the effect of Electrolyte on the rate hydrolysis (KCl, NaCl, )
21. To study some simple enzyme catalyzed reaction.
22. To study the Micellar Catalyzed Reaction.

❖ Some advanced level sophisticated instrument based (FTIR, NMR, GC-MS, AAS, FLUORESCENCE
SPECTROPHOTOMETER, TENSIOMETER etc.) experiments may be given to the students

BOOK SUGGESTED:

1. Practical Physical Chemistry by Alexander Findlay.
   Inter science.
A. SPECTROPHOTOMETRIC DETERMINATIONS
   I. Manganese / Chromium, Vanadium in steel sample.
   II. Nickel / Molybdenum / Tungsten / Vanadium / Uranium by extractive
       spectrophotometric method.
   III. Fluoride / Nitrate /Phosphate.
   IV. Iron – phenanthro line complex; Job’s Method for determination of stability
       constant of complex.
   VI. Copper –Ethylenediamine complex: Slope-ratio method.

B. pHMETRY
   Stepwise proton-ligand and metal-ligand stability constant of complexes by Leving –
   Rossoti methods.

C. POLAROGRAPHY
   Composition and stability constant of complexes.

D. FLAME PHOTOMETRIC DETERMINATIONS.
   (i) Sodium and potassium when present together
   (ii) Lithium / Calcium / Barium /Strontium.
   (iii) Calcium and Magnesium in tapwater.

E. REFRACTOMETRY
   1. Determination of the specific and molar refraction of a given liquid by Abbe
      Refractometer.
   2. Determine the variation of refractive index.
   3. To verify law of refraction of mixture (glycerol +water).

F. SEPARATION AND QUANTITATIVE ESTIMATION OF BINARY AND TERNARY MIXTURES
   BY THE USE OF FOLLOWING SEPARATION TECHNIQUES:
   1. Paper chromatography –Cadmium and Zinc, Zinc and Magnesium.
   2. Thin–layer chromatography–separation of Nickel, Manganese, Cobalt and Zinc.
   3. Ion-exchange.
   4. Solvent extraction.
   5. Electrophoretic separation.

   Some advanced level sophisticated instrument based (FTIR, NMR, GC-MS, AAS,
   FLUORESCENCE SPECTROPHOTOMETER, TENSIOMETER etc.) experiments may be given to
   the students

BOOK SUGGESTED:
   1. Quantitative Inorganic Analysis, A.I.Vogel.
   3. Practical Physical chemistry, A.M. Jamesand F.E. Prichard, Longman.
   4. Findley’s Practical Physical Chemistry, B.P.Leviu7
FOURTH SEMESTER
PAPER NO. CH - 19
INSTRUMENTAL METHODS OF ANALYSIS

Max. Marks 80

UNIT –I
ADVANCED CHROMATOGRAPHY :
A. Ionchromatography: Ion exchange equilibrium, Ion-exchange packing and Inorganic Applications.
B. Size exclusion chromatography : Column packing, Theory of size of exclusion chromatography and applications.
C. Supercritical fluid chromatography : Properties of supercritical fluid SFC-Instrumentation and operating variables, comparison with other types of chromatography, applications.
D. Capillary Electrophoresis and capillary electrochromatography: overviews and applications

UNIT –II
X-RAY AND PROTON INDUCED SPECTROSCOPY:
B. Proton Induced X-Ray Spectroscopy: Theory, instrumentaion and application

UNIT –III
ATOMIC EMISSION SPECTROSCOPY
A. Selectivity, sensitivity and interferences of atomic spectroscopy.
B. Theory, instrumentation and application of flamephotometer, AES, ICP-AES and AFS

UNIT –IV
ATOMIC ABSORPTION SPECTROSCOPY AND HYPHENATED TECHNIQUES
A. Theory instrumentation and application of flame and graphite furnace AAS, cold-vapour and hydride generation AAS.
B. Theory, instrumentation and application of hyphenated techniques i.e. GC/HPLC/-MS, GC/IC/HPLC- ICP-MS

BOOKS SUGGESTED:
1. Instrumental methods of analysis, Willard, MerittandDean.
2. Basic concepts of analytical chemistry, S.M.Khopkar, JohnWiley & Sons.
UNIT-I
A. **Terpenoids and Carotenoids**: Classification, nomenclature, occurrence, isolation, general methods of structure determination of Citral, Geraniol, α-Terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β–Carotene.
B. **Alkaloids**: Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on Nitrogen heterocyclic ring, role of alkaloids in plant. Synthesis and biosynthesis of the following: Ephedrine, (+)-Conine, Nicotine, Atropine, Quinine and Morphine.

UNIT-II
A. **Steroids**: Isolation, structure determination and synthesis of Cholesterol, Bileacids, Androstosterone, Testosterone, Esterone, Progestrone, Aldosterone and Biosynthesis of cholesterol.
B. **Plant Pigments**: Occurrence, nomenclature and general method of structure determination. Isolation and synthesis of Apigenin, Luteolin, Quercetin, Myrcetin, Quercetin-3-glucoside, Vitexin, Diadzine, Butein, Aureusin, Cyanidin, Hirsutidin.

UNIT-III
B. Concepts of drug receptors, lipophilicity, pharmacophore, pharmacological activity and typical range of parameters related to drug likeness.
C. **General introduction of pharmacokinetics and pharmaco-dynamics.**

UNIT – IV
A. **Antineoplastic Agents**: Introduction, Alkylatingagents, antimetabolites, carcinolyticantibiotics, mitoticinhibitors.
B. **Antibiotics**: Constitution and synthesis of penicillins, chloramphenicol, tetracycline and streptomycin.
C. **Antimalarials**: Synthesis and properties of the following Antimalarial drug: 8-amino quinolone derivatives- Pamaquine, Primapune, Pentaquinr, Isopentaquine, 4-aminoquinolonederivatives-Santoquine, Camaquine, Acridine derivatives- Mepracrine, Azacrin, Pyrimidine and Biguanid derivatives-Paludrine Pyremethamine.
Book Suggested:

1. Natural Products: Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs.
7. Introduction to medicinal Chemistry, A Gringuage, Wiley-VCH.
UNIT-I
NON EQUILIBRIUM THERMODYNAMICS:
Fundamental concepts, Forces and Fluxes, Entropy production, Phenomenological Laws and Onsager's theory for biological systems, coupled reactions.

UNIT-II
MATERIAL CHEMISTRY:

UNIT-III
SUPRAMOLECULAR CHEMISTRY:

UNIT-IV
NUCLEAR AND RADIOCHEMISTRY NUCLEAR THEORY:
Nuclear cross section and nuclear radii, nuclear shells and magic numbers, theory of nuclear shell model, nuclear potentials, square well and simple harmonic oscillator potentials, application, liquid drop model, semi-empirical mass equation, application and limitations.

NUCLEAR FISSION:
Mass, energy and charge distribution of fission products, decay chains, prompt and delayed neutrons, liquid drop model of nuclear fission.

NUCLEAR ENERGY:
Nuclear fission, chain reaction, multiplication factor, nuclear reactors

APPLIED RADIOCHEMISTRY:
Radioactive isotopes, purity and strength of radioisotopes. Radiochemical principle in the use of tracers, Application of Tracers in Chemical investigations, Physico-chemical methods, Analytical applications, Age determinations, Medical applications, Agricultural application.
BOOKS SUGGESTED:


8. Introduction to Theoretical Organic Chemistry and Molecular, Modelling, W.B. Smith, VCH, Weinheim.


10. Supramolecular Chemistry: concept and Perspectives, J.M. Lehn, VCH.


UNIT – I

AIR POLLUTION MONITORING AND ANALYSIS
Classification of air pollution monitoring levels, air quality, standards and index, monitoring and analysis of selected air borne pollutants: \( \text{SO}_2 \), \( \text{NO}_x \), SPM, Volatile organic compounds, \( \text{Pb} \), \( \text{CO}_2 \), Persistent organic compounds, Hg, carbon and ozone Air pollution control devices Viz ESP, scrubber technique, baghouse filters etc. Atmospheric chemistry of acid rains, photochemical smog, greenhouse effect, global warming, ozone hole.

UNIT – II

SOIL AND WATER POLLUTION
Soil and water quality standards, monitoring and analysis of selected soil and water contaminants: COD, pesticides, heavy metals, POP’s, fluoride, cyanide, nitrate, phosphate, oil & grease, Geobiochemical impact of municipal solid waste, steel plants effluent, domestic sewage. Control devices of water pollutants.

UNIT – III

FOOD ANALYSIS


UNIT – IV

COSMETICS, CLINICAL AND DRUG ANALYSIS
A. Introduction of Cosmetics, evaluation of cosmetics materials, raw material and additives, Cosmetics colors, Perfumes in cosmetics, Cosmetics formulating, introduction, standards and methods of analysis, Creams, Facepowders, Make-up, Shaving preparations, Bath preparations.

B. Concepts and principles of analytical methods commonly used in the clinical species: i.e. ammonia, Nitrogen, Ca, Cl, \( \text{CO}_2 \), Fe, K, Li, Mg, Na, P, urea, glucose.
Method for analysis of proteins (i.e. albumin, bilirubin, creatinine, cholesterol, HDL-cholesterol, triglycerides, creatinine) and Enzymes (i.e. Aanine Aminotransferase, acid phosphatase, alkaline phosphatase, amylase, aspartate, aminotransferase, cholinesterase, lactate, and lipase).
BOOKS SUGGESTED:
13. Principles of Instrumental Analysis, D.A. Skoog, W.B. Saunders.
19. APHA, 1977, “Methods of air and Health Sampling Association Washington and – Analysis US.
UNIT- I


UNIT-II


UNIT-III


UNIT-IV


BOOKS SUGGESTED:

3. Chemistry and Technology of Surfactants by R. J. FarnWiley
UNIT I

**GENERIC METHODOLOGIES FOR NANO CHEMISTRY AND NANOTECHNOLOGY**

Introduction and classification, What is nanotechnology?, Classification of nanostructures, Nanoscale architecture, Summary of the electronic properties of atoms and solids, The isolated atom, Bonding between atoms, Giant molecular solids, The free electron model and energy bands, Crystalline solids, Periodicity of crystal lattices, Electronic conduction, Effects of the nanometre length scale, Changes to the system total energy, Changes to the system structure, How nanoscale dimensions affect properties

UNIT -II

**MATERIAL CHEMISTRY**


UNIT-III

**CHARACTERIZATION METHODS**


UNIT-IV

**APPLICATIONS ON NANO CHEMISTRY**

Nanobiology, Introduction, Bio-inspired nanomaterials, Interaction between Biomolecules and Nanoparticle Surfaces, Different Types of Inorganic Materials used for the Synthesis of Hybrid Nano-bio Assemblies, Applications of Nano in Biology, Nanoprobes for Analytical Applications, Current Status of Nanobiotechnology, Future Perspectives of Nanobiology; Nanosensors, Electrochemical, Nanobiosensors, Smart Dust; Nanomedicines, Nanodrug Administration Diagnostic and Then rapeutic Applications.
BOOKS SUGGESTED:

1. Nanoparticles: From Theory to Application Edited by Günter Schmid, @ 2004 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim

2. Nanoparticles and Catalysis Edited by Didier Astruc @ 2008 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim


7. Handbook of Nanotechnology, Bharat Bhushan, Springer

8. Textbook of Nanoscience and Nanotechnology, B.S. Murty, Baldev Raj, James Murday. Springer
UNIT-I

I Basics 8Hrs

II Polymer Characterization 14Hrs

UNIT-II

III Structure and Properties 14Hrs
Morphology and order in crystalline polymers-configurations of polymer chains. Crystal structure of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical properties-crystalline melting point Tm- melting point of homogeneous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, Tg-Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking. Property requirements and polymer utilization.

IV Polymer Processing 12Hrs
Plastics, elastomers and fibres. Compounding. Processing techniques: Calendering, die casting, rotational casting, film casting, injection moulding, extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning.

UNIT-IV

V Properties of Commercial Polymers 12Hrs
Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resions and silicone polymers. Functional polymers- Fire retarding polymers and electrically conducting polymers. Biomedical polymers-contactlens, dental polymers, artificial heart, kidney, skin and blood cells.

BOOKS SUGGESTED
2. Polymer Science, V R Gowarikar, N V Viswanathan and J Sreedhar, WileyEastern
5. Polymer Chemistry introduction , Malcom T Stevens, Addison-Wesley Educational Publishers Inc.
A. **MULTI - STEP SYNTHESIS OF ORGANIC COMPOUNDS**

(i) Beckmann Rearrangement: Benzanilide from benzene (Benzene Benzophenone Benzo phenoneoxime Benzanilide).

(ii) Benzilic Acid Rearrangement: Benzilic acid from Benzoin (Benzoin Benzil Benzilicacid)

(iii) Skraup’s synthesis (Synthesis of heterocyclic Quinoline from o – Aminophenol)

(iv) p –Bromoaniline from Aniline (Aniline Acetanilide p - Bromoacetanilide p - Bromoaniline)

(v) p –NitroacetanilidedefromAcetanilide (Aniline Acetanilide p - Nitroactanilide p - Nitroaniline)

(vi) m –NitroanilinestromBenzene (Benzene Nitrobenzene m - dinitrobenzene m - nitroaniline)

(vii) Acidione from Anthranilicacid (Anthranilic acid o - Chlorobenzoic acid N - Phenylantranilic acid Acidione)

(viii) Enzymatic Synthesis

Enzymatic reduction : Reduction of ethylaceenantiomeric excess of S(+) ethyl - 3 - hydroxybutanone and determine its optical purity.

B. **QUANTITATIVE ORGANIC ANALYSIS**

(i) Estimation of Sulphur by Messenger’s Method.

(ii) Estimation of Nitrogen by Kjeldahl Method.

C. **ESTIMATION OF FUNCTIONAL GROUP**

(i) Estimation of Aniline.

(ii) Estimation of Amino Group by Acetylation Method.

(iii) Estimation of Hydroxyl Group by Acetylation Method.

(iv) Estimation of Carbonyl Group by Hydrazine Formation Method.

(v) Estimation of Carboxyl Group by Titration Method.

(vi) Determination of Equivalent Weight of Carboxylic Acid by Silver Salt Method.

(vii) Estimation of Glucose by Fehling Solution Method.

(viii) Estimation of Glycine by Titraiton Method.

D. **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 tabacco.

(v) Isolation of Cinchonine from cinchonabark.

(vi) Isolation of Piperine from blackpepper.

(vii) Isolation Lycopene from tomatoes.

(viii) Isolation of β–Carotene from carrots.

(ix) Isolation of Limonene from citrusrinds.

(x) Isolation of protein and carbohydrates from seeds – colourtest

(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-colourtest.
E. Some advanced level sophisticated instrument based (FTIR, NMR, GC-MS, AAS, FLUORESCENCE SPECTROPHOTOMETER, TENSIOMETER etc.) experiments may be given to the students.

BOOKS SUGGESTED:

1. Practical Organic chemistry by A. I. Vogel.
2. Practical Organic chemistry by Mann and Saunders.
3. Practical Organic chemistry by Gargand Saluja.
7. Small Scale Organic preparation, P. J. Hill.
A. TITRIMETRIC/GRAVIMETRIC DETERMINATIONS
   (i) Manganese in iron/Steel by Bismuthate/Linganane–Karplus/Periodate methods.
   (ii) Maganese in pyrolusite ores.
   (iii) Nickel in steel by dimethylglyoxine method.
   (iv) Lead by dithizone precipitation.

B. SPECTROPHOTOMETRIC DETERMINATION
   (i) Maganese/Chromium / Vanadium / Copper / Lead in Steel and Environmental / Industrial effluent samples.
   (ii) Nickel / Molybdenum / Tungsten / Vanadium / Uranium by extractive spectrophotometric method.
   (iii) Fluoride/Nitrite/Phosphate in tap/pond/river industrial waste water.
   (iv) Iron in water samples by thiocyanate and phenanthroline methods.

C. CHROMATOGRAPHIC SEPARATION
   1. Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values.
   2. Thin layer chromatography – separation of nickel, manganese, cobalt and zinc, Determination of Rf values.

D. FLOW INJECTION ANALYSIS.
   Determination of the following anions/cations in synthetic/real/ environmental samples.
   (i) Ca$^{2+}$, Mg$^{2+}$, Al$^{3+}$, Mn$^{2+}$, Cr$^{6+}$, Fe$^{3+}$
   (ii) F$^-$, Cl$^-$, NO$_2^-$, NO$_3^-$, PO$_4^{3-}$, SO$_2^{1-}$, BO$_3^{3-}$

E. ATOMIC ABSORPTION SPECTROPHOTOMETER
   Determination of metal contents (Fe/Pb/As/Zn/Co/Ni etc.) in real and environmental samples.

F. MISCELLANEOUS
   (i) Nutrient and micronutrient analysis in plant/soil/sediment.
   (ii) Speciation of toxic metals i.e. As, Hg, Se, etc.
   (iii) Analysis of clinical samples i.e. blood, urine, hair, etc.

   ♠ Some advanced level sophisticated instrument based (FTIR, NMR, GC-MS, AAS, FLUORESCENCE SPECTROPHOTOMETER, Tensiometer etc.) experiments may be given to the students.

BOOK SUGGESTED:
1. Quantitative Inorganic Analysis, A.I.Vogel.
4. GBC, Manuals on AAS analysis, Austria.