To learn the concepts of stereochemistry, conformational analysis and their application in the determination of reaction mechanism. To understand the mechanism of nucleophilic and electrophilic substitution reactions.

UNIT-I: STEREOCHEMISTRY

Optical activity and chirality, Classification of chiral molecules as asymmetric and dissymmetric. A brief Study of dissymmetry of allenes, biphenyls, spiro compounds, trans cyclo octane and cyclononene and molecules with helical structures absolute configuration - R, S notation of biphenyls and allenes. Fischer projection. Inter conversion of Sawhorse, Newman and Fischer projections. Molecules with more than one asymmetric center (restricted to five carbons). e.g. Erythro and threo compounds. Asymmetric synthesis. Cram’s rule.

Geometrical isomerism, E, Z - nomenclature of olefins, Geometrical and optical isomerism (if shown) of disubstituted cyclopropane, cyclobutane and cyclopentanes. Stereo specific and stereo selective reactions.

UNIT-II: CONFORMATIONAL ANALYSIS

Conformation of some simple 1, 2 - disubstituted ethane derivatives. Conformational analysis of disubstituted cyclohexane and their stereo chemical features (geometric and optical isomerism (if shown) by these derivatives). Conformation and reactivity of substituted cyclohexanol (oxidation and acylation), cyclohexanone. (reduction) and cyclohexane carboxylic acid derivatives (esterification and hydrolysis). Conformation and stereochemistry of cis and trans decalin and 9 - methyldecalin.

UNIT-III: ALIPHATIC NUCLEOPHILIC SUBSTITUTION REACTION

SN1, SN2 and SNi mechanisms - Neighboring group participation - reactivity, structural and solvent effects - substitution in norbornyl and bridgehead systems - substitution at allylic and vinlyc carbons - substitution by ambident nucleophiles - substitution at carbon doubly bonded to oxygen and nitrogen - alkylation and acylation of amines, halogen exchange, Von-Braun reaction, alkylation and acylation of active methylene carbon compounds, hydrolysis of esters, Claisen and Dieckmann condensation.

SE1, SE2 and SEi mechanism, double bond shift - Reactivity. Migration of double bond, keto-enol interconversion, HVZ reaction, Stark-Enamine reaction, halogenation of aldehydes and ketones and decarboxylation of aliphatic acids.

UNIT-IV: AROMATIC ELECTROPHILIC SUBSTITUTION REACTIONS

The arenium ion mechanism. Orientation and reactivity (ortho, meta and para directing groups). Typical reactions - nitration, halogenation, acylation and diazonium coupling, Formylation ,Reimer - Tieman reaction, Vilsmeyer - Hack, Gattermann, Gattermann - Koch ,Kolbe reaction, Synthesis of di and tri substituted benzene (symmetrical tribromo benzene, 2-amino 5-methylphenol, 3 nitro, 4-bromobenzoic acid, 3, 4-dibromonitrobenzene, 1,2,3 - trimethylbenzene) starting form benzene or any monosubstituted benzene. Electrophilic substitution of furan, pyrole, thiophene and pyridine-N-oxide.

UNIT-V: AROMATIC NUCLEOPHILIC SUBSTITUTIONS AND DETERMINATION OF REACTION MECHANISM

PAPER II
INORGANIC CHEMISTRY I

Objective
To learn about the inorganic polymers. To study the concept of coordination Chemistry, stability of the complexes and stereochemistry of complexes. To study about structure and bonding.

UNIT-I: STRUCTURE AND BONDING I
Polyacids: Isopolyacids and heteropolyacids of vanadium, chromium, molybdenum and Tungsten.
Inorganic Polymers: Silicates, structure - properties - correlation and applications - molecular sieves, polysulphur - nitrogen compounds and poly - organophosphazenes.

UNIT-II: STRUCTURE AND BONDING II
Boron hydrides: Polyhedral boranes, hydroboration, carboranes and metallo - carboranes
Metal clusters : Chemistry of low molecularity metal clusters (upto) trinuclear metal Clusters: multiple metal-metals.

UNIT-III: COORDINATION CHEMISTRY I
Stability of complexes; thermodynamic aspects of complex formation; factors affecting stability, HSAB approach. Determination of stability constants by spectrophotometric, polarographic and potentiomteric methods.

UNIT-IV: COORDINATION CHEMISTRY II
Stereochemical aspects; Stereoisomerism in inorganic complexes; isomerism arising out of ligand and ligand conformation; chirality and nomenclature of chiral complexes; optical rotatory dispersion and circular dichroism.

UNIT-V: COORDINATION CHEMISTRY III AND MACROCYCLIC LIGANDS
Macrocyclic ligands; types; porphyrins, corrins, Schiift bases; crown ethers; crypts.
Crystal field theory and its limitations, d-orbital splittings, LFSE, spectro chemical series.

ELECTIVE
PAPER I
PHYSICAL CHEMISTRY I

Objective
To study the chemical potential and its significance. To study the effect of temperature on reaction rate. To study the elements of group theory and the applications of group theory.

UNIT-I: THERMODYNAMICS I
Partial molar properties-Partial molar free energy (Chemical potential) - Partial molar volume and Partial molar heat content - Their significance and determination of these quantities. Variation of chemical potential with temperature and pressure.
Thermodynamics of real gases - gas mixture - definition of fugacity - determination of fugacity - variation of fugacity with temperature and pressure - thermodynamics of ideal and non ideal binary solutions - dilute solutions.

UNIT-II: THERMODYNAMICS II AND CHEMICAL KINETICS
Excess functions for non ideal solutions and their determination - the concept of activity and activity coefficients - determination of standard free energies - choice of standard states - determination of activity and activity coefficients for non electrolytes.
Effect of temperature on reaction rates - collision theory of reaction rate - collision cross sections - effectiveness of collisions - probability factor.

UNIT-III: CHEMICAL KINETICS
Potential energy surfaces - partition function and activated complex - Eyring equation - estimation of free energy, enthalpy and entropy of activation and their significance.
Reactions in solutions - effect of pressure, dielectric constant and ionic strength on reactions in solutions - kinetic isotope effects - linear free energy relationships - Hammett and Taft equations.

UNIT-IV: CHEMICAL KINETICS AND ELEMENTS OF GROUP THEORY
Acid - Base catalysis - mechanism of acid - base catalysed reactions - Bronsted catalysis law.
Symmetry elements and symmetry operations - group multiplication table - sub groups, similarity transformation and classes - identifications of symmetry operations and determination of point groups - reducible and irreducible representations - direct product representation.

UNIT-V: APPLICATIONS OF GROUP THEORY
Orthogonality theorem and its consequences - construction of character table for C2V and C3V - hybrid orbitals in non linear molecules (CH4,XeF4,BF3,SF6 and NH3). Determination of representations of vibrational modes in non linear molecules (H2O,CH4,BF3, and NH3).
Symmetry selection rules of infra-red and Raman spectra - application of group theory for the electronic spectra of ethylene and formaldehyde.

II SEMESTER
PAPER III
ORGANIC CHEMISTRY II
Objective
To learn the various types of reactions, rearrangements and their synthetic utility.

UNIT-I: ADDITION TO CARBON - CARBON AND CARBON - HETERO MULTIPLE BONDS
Electrophilic, nucleophilic and neighbouring group participation mechanisms - addition of halogen and nitrosyl chloride to olefins. Hydration of olefins and acetylenes. Hydroboration, hydroxylaions, Michael addition, 1, 3 - dipolar additions, Carbenes and their additions to double bonds - Simmon - Smith reaction. Mannich, Stobbe, Darzen, Wittig, Wittig - Horner and Benzoin reactions. Stereochemical aspects to be studied wherever applicable.

UNIT-II: ELIMINATION REACTIONS

UNIT-III: MOLECULAR REARRANGEMENTS
A detailed study with suitable examples of the mechanism of the following rearrangements: Pinacol - Pinacolone (examples other than tetramethylethylene glycol) - Wagner - Meerwein, Demjanov, dienone - phenol, Favorski, Baeyer - Villiger, Wolf, Stevens (in cyclic systems) and Von Richter rearrangements.

UNIT-IV: OXIDATION
Mechanism - study of the following oxidation reactions - oxidation of alcohols - use of DMSO in combination with DCC or acetic anhydride in oxidising alcohols - oxidation of methylene to carbonyl, oxidation of aryl methenes - allylic oxidation of olefins.
Formation of C=C, C-C bonds by dehydrogenation, dehydrogenation by quinones, SeO2, Hg(OAc)2 and Pb(OAc)4, Formation of C-C bond in phenol coupling - acetylene coupling-allylic oxidation-oxidation of alcohol, glycols, halides and amines to aldehydes and ketones - Ozonolysis - oxidation of Olefinic double bonds and unsaturated carbonyl compounds-oxidative cleavage of C-C bond.

UNIT-V: REDUCTION, CARBENES AND NITRENES
Carbenes and nitrenes : Methods of generation, structure, addition reactions with alkenes - insertion reactions.

PAPER IV
INORGANIC CHEMISTRY II
Objective
To study about the theories of coordination complexes, Chemistry of lanthanides, to learn about Nanotechnology and use of Inorganic Compounds in Biological Chemistry.

UNIT-I: COORDINATION CHEMISTRY
Evidence for metal ligand orbital overlap, molecular orbital theory and energy level diagrams, concept of weak and strong field ligands, Jahn-Teller, distortion, charge - transfer spectra.
Term states for “d” - ions, energy diagrams, d-d transistions, Orgel and Sugano - Tunabe diagrams, spin orbit coupling, nephelauxetic effect, spectral and magnetic characteristics of transition metal complexes.

UNIT-II: THE CHEMISTRY OF SOLID STATE I
Structure of Solids; Comparison of X-ray and Neutron Diffraction; structure of Pyrovoskite, cadmium iodide and nickel arsenide; spinels; defects in solids, non-stoichometric compounds.
Electrical, Magnetic and optical properties of solids, band theory, Semiconductors, superconductors, Solid state Electrolytes, Types of magnetic Behaviour, Dia, para, ferro, antiferro and ferrimagnetism: Hysterisis.

UNIT-III: THE CHEMISTRY OF SOLID STATE II
Solid state lasers, inorganic phosphors, Ferrites.
Reactions solid state and phase transitions, Diffusion, Diffusion coefficient Diffusion mechanisms, Vacancy and Interstitial Diffusion, Formation of spinels.

UNIT-IV: THE CHEMISTRY OF LANTHANIDES AND ACTINIDES AND NANOTECHNOLOGY
The Chemistry of solid state, lanthanides and actinides, oxidation state spectral, magnetic characteristics, coordination numbers, stereochemistry, nuclear and non-nuclear applications. Nanotechnology - introduction - preparatory methods, characterization, application as sensors, biomedical applications, application in optics and electronics.

UNIT-V: BIO-INORGANIC CHEMISTRY

PAPER V
PHYSICAL CHEMISTRY II
Objective
To study the different types of molecular spectroscopy, enzyme catalysis and kinetics of complex reactions. To study the fundamental principles of Quantum Chemistry, Schrodinger wave equation and its applications.

UNIT-I: SPECTROSCOPY I

UNIT-II: CHEMICAL KINETICS II

UNIT-III: CHEMICAL KINETICS IV

UNIT-IV: QUANTUM CHEMISTRY I
Inadequacy of classical theory - Bohr’s quantum theory and subsequent developments - the Compton effect - wave particle duality - uncertainty principle - waves - wave equation for electrons - quantum mechanical postulates-the operators - Hermitian property. Schrodinger equation - application of Schrodinger’s equation - the particle in a box (one, two and three dimensional cases).

UNIT-V: QUANTUM CHEMISTRY II
The harmonic oscillator - the rigid rotor - particle in a ring, Schrodinger equation for hydrogen atom (no derivation is required) and the solution - the origin of quantum numbers (angular momentum and spin) - their physical significance.

PRACTICAL I
ORGANIC CHEMISTRY I
Identification of components in a two component mixture and preparation of their derivatives. Determination of b.p. / m.p. for components and m.p. for the derivatives. Any Six preparation form the following
(i) Preparation of o-benzyl benzoic acid
(ii) p-Nitrobenzoic acid from p-nitrotoluene
(iii) Anthroquinone from anthracene
(iv) Benzhydrol from Benzophenone
(v) m-Nitroaniline from m-dinitrobenzene
(vi) 1,2,3,4 - Tetrahydrocarbazole from cyclohexanone
(vii) $p$-chlorotoluene form $p$-toluidine
(viii) 2,3 - Dimethyllindole from phenyl hydrazine and 2 - butanone (boiling acetic acid)
(ix) Methyl orange form sulphanilic acid
(x) Diphenyl methane from benzyl chloride

PRACTICAL II
INORGANIC CHEMISTRY I
UNIT-I
Semimicro qualitative analysis of mixture containing two common and two rare cations.
The following are the rare cations to be included. W, Ti, Te, Se, Ce, Th, Zr, V, U, Li, Mo, Be.

UNIT-II
a) Complexometric titrations (EDTA) - Estimation of Ca, Mg and Zn.
b) Preparation of the following:
   (i) Potassium tris (oxalate) aluminate (III) trihydrate
   (ii) Tris (thiourea) copper (I) chloride
   (iii) Potassium tris (oxalato) chromate (III) trihydrate
   (iv) Sodium bi (thiosphato) cuprate (I)
   (v) Tris (thiourea) copper (I) sulphate
   (vi) Sodium hexanitrocobaltate (III)
   (vii) Chloropentammine cobalt (III) chloride
   (viii) Bis (acetylacetanato) copper (II)
   (ix) Hexanrinennickel (II) chloride
   (x) Bis (thicyanato) pyridine manganese (II)
c) Separation of zinc and magnesium on an anion exchange

PRACTICAL III
PHYSICAL CHEMISTRY I
Experiments in Thermodynamics, colligative properties, phase rule, chemical equilibrium and chemical kinetics.
Typical examples are given and a list of experiments is also provided from which suitable experiments can be selected as convenient.
1. Heat of solution from Solubility measurements
2. Determination of molecular weight
3. Determination of activity and activity coefficient
4. Phase diagram construction involving two/three component systems
5. Determination of partial molar quantities
6. adsorption isotherm
7. Reaction rate and evaluation of other kinetic parameters using polarimetry, analytical techniques, conductometry, dilatometry
8. Verification of Beer Lambert law.

Detailed list of Experiments for Physical Chemistry Practical I
Typical list of possible experiments are given. Experiments of similar nature and other experiments may also be given. The list given is only a guidelines. Any 15 experiments have to be performed in a year.
1. Determine the temperature coefficient and energy activation of hydrolysis of ethyl acetate.
2. Study the kinetics of the reaction between acetone in iodine and acidic medium by half life method and determine the order with respect to iodine and acetone.
3. Study the effect of solvent (DMSO-water, acetone-water system). On the rate of acid catalysed hydrolysis of acetal by dilatometry.
4. Study the Saponification of ethyl acetate by sodium hydroxide conductometrically and determine the order of the reaction.
5. Determine the order with respect to Silver (I) in the oxidation by spt and rate constant and for uncatalysed reaction.
6. Study the inversion of cane sugar in the presence of acid using Polarimeter.
7. Determine the rate constant and order of the reaction between potassium persulphate and potassium iodide and determine the temperature coefficient and energy of activation of the reaction.
8. Study the effect of ionic strength on the rate constant for the saponification of an ester.
9. Study the salt effect on the reaction between acetone and iodine.
10. Study the kinetics of the decomposition of sodium thiosulphate by mineral acid (0.5M HCl).
11. Study the primary salt effect on the kinetics of ionic reactions and test the Bronsted relationship (iodide ion is oxidized by persulphate ion).
12. Study the kinetics of enzyme catalysed reactions (Activity of tyrosinase upon tyrosine spectrophotometrically).
13. Study the salt effect, the solvent effect on the rate law of alkaline hydrolysis of crystal violet.
14. Study the reduction of aqueous solution of ferric chloride by stannous chloride.
15. Determine the molecular weight of benzoic acid in benzene and find the degree of association.
16. Determine the activity coefficient of an electrolyte by freezing point depression method.
17. Study the phase diagram for a simple binary system naphthalene - phenantherene and benzophenone-diphenyl amine.
18. Construct the phase diagram for a simple binary system tyrosinase upon tyrosine spectrophotometrically.
19. Construct the boiling point composition diagram for a mixture having maximum boiling point and minimum boiling point.
20. Study the complex formation between copper sulphate and ammonia solution by partition method.
21. Study the simultaneous equilibria in benzoic acid - benzene water system.
22. Determine the degree of hydrolysis and hydrolysis constant of aniline hydrochloride by partition method.
23. Determine the molecular weight of a polymer by viscosity method.
24. Determine the viscosities of mixtures of different compositions of liquids and find the composition of a given mixture.
25. Determine the partial molal volume of glycine/methanol/formic acid/sulphuric acid by graphical method and by determining the densities of the solutions of different compositions.
26. Study the temperature dependence of the solubility of a compound in two solvents having similar intermolecular interactions (benzoic acid in water and in DMSO water mixture) and calculate the partial molar heat of solution.
27. Determine the polar molar volume of glycine/methanol/formic acid/sulphuric acid by graphical method and by determining the densities of solutions of different concentrations.
28. Construct the phase diagram of the three component of partially immiscible liquid system (DMSO-water-benzene; acetone-chloroform - water; chloroform-acetic acid-water).
29. Construct the phase diagram of a ternary aqueous system of glucose - potassium chloride and water.
30. Study the surface tension - concentration relationship for solutions (Gibb’s equation).
31. Study the absorption of acetic acid by charcoal (Freundlich isotherm).
32. Study the complex formation and find the formula of silver-ammonia complex by distribution method.
33. Determine the dissociation constant of picric acid using distribution law.
34. Construct a chemical actinometry and determine the quantum yield and calibrate the lamp intensity.
Synthesis of simple organic molecules using standard reaction like acetylation alkylation of enamines and active methylene compounds, Grignard reactions, Phosphorus and sulphurylides Robinson annulation, Diels Alder reactions, protection and deprotection of functional groups (R-OH, R-CHO, RCO-R, R-NH2 and R-COOH).

Uses of the following reagents: DCC, Trimethylsilyliodide, 1, 3-Dithiane (umpolung), diisobutylaluminiumhydride (DIBAL), 9BBN, Trimethylsilylchloride.

UNIT-IV: PLANNING ORGANIC SYNTHESIS AND RETROSYNTHETIC ANALYSIS
(Synthesis of the following target molecules: longifolene, cubane, 5-hexenoic acid, trans-9-methyl l-decalone, bicyclo (4,1,0) heptan-2 one and onocerin.

An introduction to retrosynthesis - Synthon, Synthetic equivalent, Target molecule, Functional group interconversion - Disconnection approach - One group disconnection - Disconnection of alcohols, olefins and ketones - Logical and illogical disconnections, Two group disconnection - 1,2 - 1,3 - 1,4 - 1,5 - and 1,6 - deoxygenated skeletons and dicarbonyls. Retro Diels Alder reaction - pericyclic reactions - Retrosynthesis of some heterocycles containing two nitrogen atoms.

UNIT-V: HETEROCYCLES, VITAMINS AND STEROIDS
Imidazole, oxazole, thiazole, flavones, isoflavones, anthocyanins, pyrimidines (cytocine and L racil only) and purines (adenine. Guanine only). Synthesis of parent and simple alkYI or aryl substibution derivatitives are expected. Synthesis of vitamin A1 (Reformatsky and Wittig reaction methods only). Conversion of cholesterol to progesterone, estrone and testosterone.

III SEMESTER
PAPER VI
INORGANIC CHEMISTRY III
Objective
To study about the Coordination complexes, Substitution in Coordination complexes, to study the Inorganic Photochemistry.

UNIT-I: ORGANO METALLIC CHEMISTRY I
Carbon donors: Alkyls and aryls metalation, bonding in carbonyls and nitrosyls, chain and cyclic donors, olefins, acetylene and allyl system synthesis structure and bonding Metallocenes.

Reactions : Association substitution, addition and elimination ligand promotion, electrophilic and nucleophilic attack on ligands. Carbyonylation. Decorboxylation, oxidative addition and fluxionality.

UNIT-II: ORGANO METALLIC CHEMISTRY II
Catalysis : Hydrogenation of olefins (Wilkinson’s catalyst), hydroformylation of olefins using cobalt or rhodium catalysts (oxo process), oxidation of olefins to aldehydes and ketones (Wacker process) polymerization (Zeigler - Natta Catalyst); cyclo oligomerisation of acetylene using nickel catalyst (Repee’s catalyst); polymer-bound catalysts.

UNIT-III: COORDINATION CHEMISTRY
Electron transfer reactions, outer and inner sphere processes; atom transfer reaction, formation and rearrangement of precursor complexes, the binding ligand, successor complexes, Marcus Theory. Complementary, non-complementary and two electron transfer reactions.

UNIT-IV: COORDINATION CHEMISTRY
Substitution Reactions: Substitution in square planar complexes, reactivity of plantium complexes, influences of entering, leaving and other groups, the trans effect.

UNIT-V: COORDINATION CHEMISTRY AND INORGANIC PHOTOCHEMISTRY
Substitution of octahedral complexes of cobalt and chormium, replacement of corodinated water, solvolytic (acids and bases) reaction applications in synthesis (platinum and cobalt complexes only).

Inorganic Photochemistry: Photo-substitution, Photoredox and isomerisation process, application of metal complexes in solar energy conversion.

PAPER VII
PHYSICAL CHEMISTRY III
Objective
To study the application of Quantum Chemistry to chemical bonding. To study the ionic conductance, Electrode - Electrolytic interface. To study the kinetics of polymerization and to study NMR spectroscopy and its applications.

UNIT-I: QUANTUM CHEMISTRY II
Approximation methods - perturbation and variation methods - application to hydrogen and helium atoms.

UNIT-II: ELECTROCHEMISTRY I

UNIT-III: ELECTROCHEMISTRY II

UNIT-IV: MACROMOLECULES

UNIT-V: SPECTROSCOPY II

ELECTIVE
PAPER III ORGANIC CHEMISTRY III
Objective
To understand the concepts of spectral techniques and to apply these techniques for the quantitative and structural analysis of organic compounds. To learn free radicals reactions, antibiotics and their importance.

UNIT-I: UV AND IR SPECTROSCOPY AND ITS APPLICATIONS
Ultraviolet - Visible spectroscopy - types of electronic transitions - chromophores and auxochromes - factors influencing positions and intensity of absorption bands - absorption spectra of dienes, polyenes and unsaturated carbonyl compounds - Woodward - Fiser rules.
IR Spectroscopy - vibrational frequencies and factors affecting them - identification of functional groups - intra and inter molecular hydrogen bonding - finger print region - Far IR region - metal ligand stretching vibrations.

UNIT-II: NMR SPECTRA AND ITS APPLICATIONS
Nuclear spin - magnetic movement of a nucleus - nuclear energy levels in the presence of magnetic field relative populations of energy levels - macroscopic magnetization - basic principles of NMR experiments - CW and FT NMR - 1H NMR - chemical shift and coupling constant - factors influencing proton chemical shift and vicinal proton - proton coupling constant - 1H NMR spectra of simple organic molecules such as CH3CH2Cl, CH3CHO etc. AX and AB spin system - spin decoupling - nuclear overhauser effect- chemical exchange. 13C NMR - proton decoupled and off - resonance 13C NMR spectra - factors affecting 13C chemical shift - 13C NMR spectra of simple organic molecules. Problem solving (for molecules with a maximum number of C10).

UNIT-III: PHYSICAL METHODS OF STRUCTURAL DETERMINATION

UNIT-IV: ANTIBIOTICS
Introduction, structural elucidation and synthesis of pencillin, streptomycin, chloromycetin and tetracyclines.

UNIT-V: FREE RADICALS
Long and short-lived free radicals, methods of generation of free radicals. Addition of free radicals to olefinic double bonds. The following aromatic radical substitutions are to be studied: decomposition of diazocompounds, phenol -
coupling - Sandmeyer reaction Gomberg reaction, Pschorr reaction, Ulmann reaction, mechanism of Hunsdiecker reaction Detection of free radicals by ESR.

**ELECTIVE NON MAJOR SUBJECT**

**PAPER IV**

**APPLIED CHEMISTRY**

**UNIT-I: CHEMISTRY OF WATER:**

**UNIT-II: CHEMISTRY OF DRUGS:**
Classification of drugs - Administration of Drug - Absorption of drugs - Elimination of drug by Kidney - Some important drugs - Antibiotics, Anti malarials, anti asthmatic drugs - Anti bacterial drugs, anti septs, anesthetics, analgestics and anti pyretic drugs. (Role and examples in each type) - Misuse of drugs.

**UNIT-III: CHEMISTRY OF POLYMERS**
Classification of polymers - Addition and condensation polymers - Polymerisation reaction - co-polymers - homopolymers - Thermoplastics and thermostets - Molecular weight of polymers - Rubbers - Inorganic polymers - Biopolymers - Domestic and industrial application of polymers.

**UNIT-IV: CHEMISTRY OF MATERIALS:**

**UNIT-V: CHEMISTRY OF ENVIRONMENTAL POLLUTANTS:**

**IV SEMESTER**

**PAPER VIII**

**ORGANIC CHEMISTRY - IV**

**Objective**
To understand the concepts of Photochemical Reactions, Aromaticity Carbohydrates Terpenes, Applications and Techniques of Dyeing.

**UNIT-I: AROMATICITY**
Aromaticity of benzenoid, heterocyclic, and non-benzenoid compounds, Huckel’s rule - Aromatic systems with pi electron numbers other than six - non-aromatic (cyclo octatetraene etc,) and anti aromatic system (cyclobutadiene etc.) - system with more than 10pi electrons - Annulenes upto C18 (synthesis of all these compounds is not expected).

**UNIT-II:**
Photochemical excitation - fate of the excited molecules - joblonski diagram - study of photochemical reactions of ketone - photoreduction - photocyclo addition - Paterno - Buchi reaction - di pi-methane rearrangement - Pericyclic Analysis of electrocyclic, cyclo addition and sigmatropic reactions - correlation diagrams for butadiene - cyclobutene system hexatriene to cyclohexadiene system. Structure of bulvalene, a fluxional molecule - Cope and Claisen rearrangement.

**UNIT-III: CARBOHYDRATES**
Introduction, structure determination of disaccharides - Maltose, Sucrose, Cellobiose and lactose. Polysaccharides, structure determination of cellulose and starch.

**UNIT-IV: TERPENES**
Introduction, classification, isoprene rule, structural determination of terpenoids citral, Geraniol, Linalool, Farnesol, α-pinene and camphor.

**UNIT-V: DYES**
To study the electrochemical kinetics, over potential, corruptions and fuel cells. To study statistical thermodynamics, Quantum statistics and reversible thermodynamics. To study the principle of photochemical reactions, kinetics - Stern - Volmer Analysis.

UNIT-I: ELECTROCHEMISTRY III
Mechanism of electrode reactions - polarization and overpotential - the Butler-Volmer equation for one step and multistep electron transfer reactions - significance of electron exchange current density and symmetry factor - transfer coefficient and its significance - mechanism of the hydrogen and oxygen evolution reactions. Corrosion and passivation of metals - Pourbaix diagram - Evan’s diagram - fuel cell - electrodeposition - principle and applications.

UNIT-II: STATISTICAL THERMODYNAMICS I

UNIT-III: STATISTICAL THERMODYNAMICS II

UNIT-IV: PHOTOCHEMISTRY I

UNIT-V: PHOTOCHEMISTRY II

PAPER X
SCIENTIFIC RESEARCH METHODOLOGY

Objective
To study about the importance of research, literature survey, error analysis, statistical treatment. To study about the conventions of writing thesis.

UNIT-I: INTRODUCTION
Nature and importance of research - aims, objective, principles and problems - selection of research problem - survey of scientific literature - primary and secondary sources - citation index for scientific papers and journals - patents.

UNIT-II: CONDUCT OF RESEARCH WORK
Physical properties useful in analysis and methods of separation prior to analysis - Isolation techniques - extraction - Soxhlet extraction, crystallization, sublimation - methods for vacuum sublimation and distillation under reduced pressure. Chemistry of working with hazardous materials - acid / water sensitive, corrosive, toxic, explosive and radioactive materials.

UNIT-III: EVALUATION OF ANALYTICAL DATA
Precision and accuracy - Reliability - determinate and random errors - distribution of random errors - normal distribution curve.

UNIT-IV: STATISTICAL TREATMENT OF ANALYTICAL DATA
Statistical treatment of finite samples - the students test and F test - Criteria for rejection of an observation - the Q test, significant figures and computation rules - data plotting - least square analysis.

UNIT-V: THESIS AND ASSIGNMENT WRITING
Conventions of writing - the general format - page and chapter format - use of quotations and footnotes - preparation of tables and figures - referencing - appendices - Revising editing and evaluating the final product - proof reading - Meanings and examples of commonly used abbreviations.

PRACTICAL IV
ORGANIC CHEMISTRY II

ANY SIX PREPARATIONS FROM THE FOLLOWING INVOLVING TWO STAGES
1. sym-Tribromo benzene from aniline.   2. Benzanilide from benzophenone
3. m-Nitro benzoic acid from methyl benzoate 4. 2,4-Dinitrobenzoic acid from p-nitrotoluene
5. m-Nitro benzoic acid from benzaldehyde 6. Benzil form benzaldehyde
7. Anthraquinone from phthalic anhydride 8. Phthalide from phthaic anhydride
9. 2-Phenyl indole from phenyl hydrazine 10. 2, 4 dinitrophenyl hydrazine from p-nitrochlorobenzene

ANY TWO EXERCISES IN THE EXTRACTION OF NATURAL PRODUCTS
1. Caffeine from tea leaves    2. Lactose from milk
3. Citric acid from lemon 4. Piperine from black pepper

CHROMATOGRAPHIC SEPARATIONS
1. Column chromatography - separation of anthracene and picric acid from anthracene picrate.
2. Thin layer chromatography separation of green leaf pigments.

ANY FIVE ESTIMATION
1. Estimation of aniline 2. Estimation of phenol
3. Estimation of glucose 4. Estimation of amino group
5. Estimation of amide group 6. Sapanification of fat or an oil
9. Estimation of methyl ketone

IV SPECIAL INTERPRETATION OF ORGANIC COMPOUNDS UV, IR, PMR AND MASS SPECTRA OF 15 COMPOUNDS
1. 1,3,5-Trimethyl benzene 2. Pinacolane
3. n-Propylamine 4. p-Methoxy benzyl alcohol
5. Benzyl bromide 6. Phenylacetone
7. 2-Methoxyethyl acetate 8. Acetone
9. Isoopropyl alcohol 10. Acetaldehyde diacetate
11. 2-N,N-Dimethylamino ethanol 12. Pyridine
13. 4-Picoline 14. 1,3-dibromo - 1, 1- dichloropropene
15. Cinnamaldehyde

PRACTICAL V INORGANIC CHEMISTRY II QUANTITATIVE ANALYSIS OF COMPLEX MATERIALS
A. Analysis or ores
1. Determination of percentage of calcium and Magnesium in dolomite.
2. Determination of percentage of MnO2 in pyrolusite.
3. Determination of percentage of lead in galena.

B. Analysis of alloys
1. Estimation of tin and lead in solder. 2. Estimation of copper and zinc in brass.
3. Estimation of chromium and nickel in stainless steel.  D. Analysis of inorganic complex compounds
4. Preparation of cis and trans potassium bis (Oxalato) diaquochromate and analysis of each of these for Chromium.
2. Preparation of potassium tris (Oxalato) ferrate (III) and analysis for iron and oxalate.

QUANTITATIVE ANALYSIS
Quantitative analysis of mixtures of iron and Magnesium; iron and nickel; copper and nickel and copper and zinc.

E. CALORIMETRIC ANALYSIS
(Using) Photoelectric method: Estimation of iron, nickel, manganese, copper,
F. BIAMPEROMETRIC TITRATIONS
(With dead stop endpoint) thiosulphate - iodine system and Iron (II) - cerium (IV) system

G. LIST OF SPECTRA TO BE GIVEN FOR INTERPRETATION.
1. 31p NMR Spectra of methylphosphate 2. 31p NMR Spectra of HPF2
3. 19F NMR Spectra of CIF3 4. 1H NMR Spectra of Tris (ethythioacctoacetanato) cobalt (III)
5. Explained high resolution 1 H NMR spectra of (N-propylisonitrosoacctylacetoneuninato) (acetylacetoneinato) Nickel (II)
6. ESR Spectra of the aqueous ON(SO3)2- ion.
7. ESR Spectra of the H atoms in CaF2.
8. ESR Spectra of the (Mn (H2O)6)2+.
9. ESR Spectra of the bis (salicyladiminato) copper (II).
10. IR Spectra of the sulphato ligand.
11. IR Spectra of the dimethylglyoxime ligand and its Nickel (II) complex.
12. IR Spectra of carbonyls.
13. Mossbauer spectra of FeSO4 7H2O.
14. Mossbauer spectra of FeCl3.
15. Mossbauer spectra of (Fe(CN)6)3-.
16. Mossbauer spectra of (Fe (CN6).

PRACTICAL VI
PHYSICAL CHEMISTRY II

Experiment in electrochemistry, conductometry, potentiometry pH metry and spectroscopy.

Conductivity measurements
1. Determination of equivalent conductance of a strong electrolyte and verification of Debye - Huckel - Onsager Equation
2. Verification of Debye-Huckel limiting law
4. Conductometric titrations between acid (simple and mixture of strong and weak acids) - base, precipitation titrations including mixture of halides.

E.M.F measurements
Determination of standard potentials ( Copper & Zinc)
1. Determination of thermodynamic quantities from EMF measurements - potentiometric titrations.
3. Determination of stability constant of a complex.
5. Precipitation titration of mixture of halides by E.M.F measurements.

Spectroscopy
Experiments given only to familiarize the interpretation of spectra provided. Interpretation of simple UV-visible spectra of simple molecules for the calculation of molecular data and identification of functional groups (5 typical spectra will be provided).

IR and NMR spectral calculations of force constant - identification and interpretation of a spectra (5 each in IR and NMR will be provided).

List of experiments suggested for Physical Chemistry Practical II
Typical list of possible experiments are given. Experiments of similar nature and other experiments may also be given. The list given is only a guidelines. Any 15 experiments have to be performed in a year.
1. Determination of the equivalent conductance of a weak acid at different concentrations and verify Ostwalds dilution law and calculate the dissociation constant of the acid.
2. Determination of equivalent conductance of a strong electrolyte at different concentrations and examine the validity of the Onsager's theory as limiting law at high dilutions.
3. Determination of the activity co-efficient of Zinc ions in the solution of 0.002M Zinc sulphate using Debye-Huckel limiting law.
4. Determination of the solubility product of silver bromate and calculate its solubility in water and in 0.01 M KBrO3 using Debye-Huckel limiting law.
5. Conductometric titrations of a mixture of HCl, CH3COOH and CuSO4 and NaOH.
6. Determination of the dissociation constant of an acid at different dilution.
7. Determination of the solubility of the lead iodide in water, 0.04 M KI and 0.04 M Pb(NO3)2 at 298 K
8. Determination of the solubility product of lead iodide at 298 K and 308 K and calculate the molar heat of solution of lead iodide.
9. Compare the relative strength of acetic acid and monochloroacetic acidby conductance method.
10. Determine the basicity of organic acids (oxalic / benzoic )
11. Determine the electrode potentials of Zn and Ag electrodes in 0.1M and 0.001M solutions at 298 K and fine the standard potentials for these electrodes and test the validity of Nernst equation.
12. Determine the activity co-efficient of an electrolyte at different molalities by EMF measurements.
13. Determine the dissociation constant of acetic acid titrating it with sodium hydroxide using quinhydrone as an indicator electrode and calomel as a reference electrode.
14. Study of the electrolytic separation of metals (Ag, Cu, Cd and Zn)
15. Determine the strength of a given solution of KCl using differential potentiometric titration technique.
16. Determine the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.
17. Determine the transport number of Ag ions and nitrate ions by Hittorf’s method.
18. Determine the transport number of cadmium ions and sulphate ions by measuring emf of concentration cells with and without transference.
19. Determine the dissociation constant of monobasic or dibasic acid by the Alber-Serjeant method.
20. Determine the pH of the given solution with the help of indicators using buffer solutions and by colorimetric method.
22. Determine the pH of a given solution by emf method using glass and calomel electrodes and evaluate pKa value of an acid.
23. Determine the pH of a given solution by emf methods using hydrogen electrode and quinhydrone electrode.
24. Estimate the concentration of cadmium and lead ions by successive reduction in polarography.
25. Verify Illkovic equation
26. Determine lead ion by amperometric titrations with potassium dichromate.
27. Determine ferric ion by amperometric titration.
28. Determine pH value of an acid –base indicator (methyl red) by colorimetry
29. Determine the composition and instability constant of a complex by mole ratio method.
30. By colorimetry determine simultaneously Mn and Cr
31. Study the effect of solvent on the conductivity of AgNO3/ acetic acid and determine the degree of dissociation and equilibrium constant in different degree of dissociation and mixtures (DMSO, DMF, dioxane, acetone, water) and test the validity of Debye-Huckel Onsager’s equation.
32. Determine the solubility of Ca(TiO3)2 in deionised water and in dilute solution of KCl at 298 K. Determine the solubility product graphically.
33. Determine the equivalent conductivity of a Ca electrolyte and dissociation constant of the electrolyte.
34. Determine the equivalent dissociation constant of a polybasic acid.
35. Calculate the thermodynamic parameters for the reaction Zn + H2SO4 \( \rightarrow \) ZnSO4 + H2 by emf method.
36. Determine the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometrically.
37. Determine the stability constant of a complex by polarographic method.
38. Determine the g value from a given ESR spectrum.

**ELECTIVE PAPER V**

**INORGANIC CHEMISTRY IV**

**Objective**

**UNIT-I: INORGANIC SPECTROSCOPY I AND MAGNETIC PROPERTIES**

Applications to inorganic systems of the following: ultra violet, visible, infra-red and Raman spectra of metal complexes, organo-metallic and simple inorganic compounds with special reference to coordination sites, isomerism.

Magnetic Susceptibility and measurements - Guoy method, Faraday method; applications.

**UNIT-II: APPLICATION TO INORGANIC SYSTEMS OF THE FOLLOWING**

NMR, NQR and Mossbauer spectra - NMR of 31P, 19F, NMR shift reagents. NQR - Nitrosyl compounds. Mossbauer spectra of Fe and Sn systems.

**UNIT-III: INORGANIC SPECTROSCOPY**

ESR Introduction - Zeeman equation, g-value, nuclear hyperfine splitting, interpretation of the spectrum, simple carbon centered free radicals. Anisotropy - g-value and hyperfine splitting constant. Mcconnel’s equation, Kramers theorem. ESR of transition metal complexes of copper, manganese and vanadyl complex.

Photoelectron spectroscopy (UV and X-ray) - photo electron spectra - Koopman’s theoreom, time structure in PES, chemical shift and correlation with electronic charges. (5 Hrs.)

**UNIT-IV: NUCLEAR CHEMISTRY I**

Nuclear properties: Nuclear spin and moments, origin of nuclear forces, salient features of the liquid drop and the shell models of the nucleus.

Models of Radioactive Decay: Orbital electron capture: nuclear isomerism, internal conversion, detection and determination of activity by cloud chamber, nuclear emulsion, bubble chamber, G.M., Scintillation and Cherenkov counters.
Nuclear Reaction: Types, reactions, cross section, Q-value, threshold energy, compound nucleus theory: high energy nuclear reactions, nuclear fission and fusion reactions as energy sources; direct reactions; photonuclear and thermo nuclear reactions.

UNIT-V: NUCLEAR CHEMISTRY II

Stellar energy: synthesis of elements, hydrogen burning, carbon burning.
Nuclear Reactors: fast breeder reactors, particle accelerators, linear accelerators, cyclotron and synchrotron.
Radio Analytical Methods: Isotope dilution analysis, Radiometric Titrations, Radio immuno assay, Neutron activation analysis.