

**BHARATHIAR UNIVERSITY, COIMBATORE.**  
**M. Sc. CHEMISTRY DEGREE COURSE (AFFILIATED COLLEGES)**  
**(Effective from the academic Year 2015 - 2016 onwards)(REVISED)**

SCHEME OF EXAMINATIONS

Study Components	Course Title	Inshrs/ Week	Exam				Credits
			Dur. Hrs.	CIA*	Univ Exam	Total	
<b>Semester I</b>							
Paper I	Organic Chemistry – I (Organic Reaction Mechanism)	5	3	25	75	100	4
Paper – II	Inorganic Chemistry – I (Inorganic Rings and Nuclear chemistry)	5	3	25	75	100	4
Paper – III	Physical Chemistry I (Group theory nanoscience and Computers in Chemistry)	5	3	25	75	100	4
Practical - I	Organic Chemistry - I	4	--	--	--	--	--
Practical – II	Inorganic Chemistry - I	4	--	--	--	--	--
Practical – III	Physical Chemistry - I	4	--	--	--	--	--
Elective – I		3	3	25	75	100	4
<b>Semester II</b>							
Paper – IV	Organic Chemistry – II (Molecular rearrangements and Photochemistry)	5	3	25	75	100	4
Paper _ V	Physical Chemistry II (Quantum chemistry and nanomaterials)	5	3	25	75	100	4
Paper – VI	Physical methods in Chemistry I	5	3	25	75	100	4
Practical - I	Organic Chemistry - I	4	6	40	60	100	4
Practical – II	Inorganic Chemistry - I	4	6	40	60	100	4
Practical – III	Physical Chemistry - I	4	6	40	60	100	4
Elective – II		3	3	25	75	100	4
<b>Semester III</b>							
Paper -VII	Organic Chemistry - III(Chemistry of natural Products)	5	3	25	75	100	4
Paper – VIII	Physical Chemistry – III (Thermodynamics)	5	3	25	75	100	4
Paper –IX	Physical Methods in Chemistry II	5	3	25	75	100	4
Practical - IV	Organic Chemistry - II	4	--	--	--	--	--
Practical – V	Inorganic Chemistry - II	4	--	--	--	--	--
Practical – VI	Physical Chemistry - II	4	--	--	--	--	--
Elective – III		3	3	25	75	100	4
<b>Semester IV</b>							
Paper – X	Inorganic Chemistry – II (Coordination	5	3	25	75	100	4

Chemistry)						
Paper IX Physical Chemistry IV (Reaction Kinetics and Electrochemistry)	5	3	25	75	100	4
Paper – XII Polymer Technology	5	3	25	75	100	4
Practical - IV Organic Chemistry - II	4	6	40	60	100	4
Practical – V Inorganic Chemistry - II	4	6	40	60	100	4
Practical – VI Physical Chemistry - II	4	6	40	60	100	4
Elective – IV (Option given to choose either project work or Elective paper)	3	3	-	-	100**	4
Practical Viva	--		50		50	2
Total					2250	90

Electives: List of group elective papers (colleges can choose any one of the group papers as electives)

	Group A	Group B	Group C
Paper I/Sem I	Dye Chemistry	Green Chemistry	Green Chemistry
Paper II/ Sem II	Water Pollution and Industrial Effluents treatment	Water Pollution and Industrial Effluents treatment	Advanced Polymeric materials
Paper III/ Sem III	Organic Synthetic Methodology, Oxidation and Reduction	Medicinal Chemistry	Kinetics of polymerization
Paper IV/ Sem IV Theory paper (or) Project work	Industrial Chemistry	Applied Electro Chemistry	Pharmaceutical Chemistry

\* Includes 25 & 40% continuous internal assessment marks for theory and practical papers, respectively.

\*\* For Project report - 80%; Viva-voce - 20%

**Subject Title:** Paper- I Organic Chemistry – I (Organic Reaction Mechanisms)  
**No of Hours: 75**

**Subject Description :**

This contents of this paper present the basic principles of understanding mechanism of organic reactions. In addition to the general physical methods of approaching the course of reactions, specific examples like aromatic electrophilic substitution, aliphatic nucleophilic substitution, elimination and free radical reactions have been dealt in detail.

**Goals :**

To motivate and enable the students to comprehend the possible chemical route by which a reaction may proceed.

**Objectives :** On successful completion of the course the students should have: Understood aromaticity, antiaromaticity and nonaromaticity in organic compounds, Learnt possible reaction pathways in aromatic electrophilic, aliphatic nucleophilic, elimination and free radical reactions.

**Contents**

**UNIT-I**

1. Aromaticity : Criteria, Non-benzenoid aromatics – annulenes, Azulenes and ferrocenes(synthesis not necessary). Anti-aromatic and non aromatic compounds – Homoaromaticity.  
2. Kinetic and nonkinetic methods of study of reaction mechanisms - Primary and secondary kinetic isotopic effects, non-kinetic methods of study of reaction mechanism — study of intermediates, isotopic labeling, stereochemical studies and cross over experiments. Hammond's postulate. Kinetic and thermodynamic control. 3. Linear free energy relationship — Hammett equation (Taft equation not necessary).

**UNIT—II**

Aromatic electrophilic substitution reactions: Mechanism, orientation and reactivity in mono substituted benzene rings. Activating and deactivating groups. Ortho/para ratio- *ipso* attack, orientation in disubstituted benzene rings. Typical reactions such as Friedel Crafts alkylation & acylation, Reimer- Tiemann, Vilsmeier- Haack reaction, Hofmann-Martius and Jacobsons reaction. Aliphatic electrophilic substitution reactions, Mechanism of  $SE^1$ ,  $SE^2$  and  $SE^i$  reaction. Stork-enamine reaction.

**UNIT-III**

Aliphatic nucleophilic substitution reactions and mechanisms:  $SN_1$ ,  $SN_2$ ,  $SN_i$  mechanisms. Factors affecting nucleophilic substitution reaction – nature of the substrate, solvent, nucleophile and leaving group. Neighbouring group participation. Ambident nucleophiles and ambident substrates. Stereochemistry of nucleophilic substitution reactions.

Substitution at vinyl carbon allylic carbon and bridge head carbon. Typical substitution reactions such as Von Braun reaction, Claisen condensation and hydrolysis of esters.

Aromatic Nucleophilic Substitution reactions:  $SN_1$ ,  $SN_{Ar}$  and Benzyne mechanisms (Ziegler alkylation and Chichibabin reaction).

#### **UNIT- IV**

1. Elimination reactions: E1, E2, Ei, E1CB mechanisms, Hoffman and Sayetzeff rules, Stereochemistry of elimination reactions. Elimination Vs substitution. Typical elimination reactions such as Chugaev reaction. Hofmann degradation. Cope elimination.
2. Carbenes and nitrenes — structure, generation and reactions.

#### **UNIT-V**

Free radical reactions: Introduction -structure, stability and geometry of free radicals. Generations of long lived and short lived free radicals. Characteristics of free radical reactions - substitutions - additions and eliminations, rearrangements. of free radicals. Typical reactions such as Sandmeyer, Gamberg, Pechmann, Ullman, Pschorr and Hunsdiecker reactions.

#### **REFERENCES**

1. Jerry March — Advanced organic chemistry
2. I.I. Finar — Organic chemistry. Vol. 1 & II
3. R.T. Morrison and R.N. Boyd — Organic chemistry
4. E.S. Gould — Mechanism and structure in organic chemistry
5. E. R. Alexander — Principles of ionic organic reactions
6. Fieser and Fieser — Advanced organic chemistry
7. J.B. Hendrickson, D.J.Gram and G.S.Hammond — Organic chemistry
8. P.J. Garrat — Aromaticity
9. Badger — Aromaticity and aromatic character
10. D.V. Banthorpe — Eliminations

Subject title : **Paper –II -INORGANIC CHEMISTRY – I**  
(Inorganic Rings and Nuclear chemistry)

No.of hours: 75 hrs

#### **Subject Description :**

This paper presents an idea about inorganic ring systems and clusters and Nuclear Chemistry

#### **Goals :**

To enable the students to learn some principles and theories in inorganic and solid state chemistry and nuclear chemistry

#### **Objectives :**

On successful completion of the course the students should have an exposure to Inorganic clusters and nuclear chemistry

#### **Contents**

##### **UNIT – I**

Inorganic rings – chains – cages and clusters – metal clusters – dinuclear, trinuclear, tetra nuclear and hexa - nuclear clusters – organometallic clusters.

##### **UNIT – II**

Borazines – phosphonitrilic compounds – sulphur - nitrogen ring compounds.

Metallic state – free electron and band theories – non stoichiometry – point defects in solids – Schottky - Frenkel defects – linear and dislocation effects.

### **UNIT – III**

Electrical properties of solids – superconducting elements – critical temperature – persistent currents – thermoelectric properties – magnetic properties (perfect diamagnetism) – Meissner effect

### **UNIT – IV**

Nuclear chemistry-the nuclues-subatomic particles and their properties –binding energy- N-P ratio in stable and metastable nucluei-different types of nuclear forces-liquid drop model-shell model-mode of radioactive decay- $\alpha$ , $\beta$ , $\gamma$  decay-electron capture-nuclear isomerism-internal conversion.

### **UNIT – V**

Nuclear reactions Q-value, coulombic barrier, cross section, different types of nuclear reactions-projectiles capture – particle emission, spallation, fission, fusion & theories of fission, use of fission products, fissile and fertile isotopes –  $U^{233}$ ,  $U^{235}$ ,  $Pu^{239}$ ,  $Th^{232}$ , - atomic power projects in India, stellar energy, synthetic elements – application of radio isotopes-hot atom chemistry.

### **References :**

1. Cotton and Wilkinson : Advanced inorganic Chemistry, Wiley Eastern (P), Ltd., 1968
2. Gurdeep and Harish : Advanced inorganic Chemistry, Geol Publishing House
3. G.M.Arora : Solid State Chemistry
4. R.A.Alberty and Silbey : Solid State Chemistry
5. J.P.Srivastava : Elements of Solid State Physics
6. Glasstone : Source book of nuclear of chemistry

## **PAPER III- PHYSICAL CHEMISTRY – I (Group Theory, Nanoscience and Computer in Chemistry)**

**No.of hours: 75 hrs**

### **Subject Description:**

This paper presents an idea about group theory and the basic concepts of nanoscience and the computer applications in Chemistry.

### **Goals :**

To enable the students to learn group theory, nanoscience and computer application concept

### **Objectives :**

On successful completion of the course the students should have an exposure to the group theory and nano technology and a basic idea of computers in chemistry.

### UNIT - I

Symmetry elements and symmetry operations: definition of identical and equivalent elements configurations- symmetry operations and symmetry elements-rotation-axis of symmetry-reflections symmetry planes-inversion center-improper rotations-rotation-reflection axis-effect of performing successive operations (commutative and non - commutative) - inverse operations.

Groups and their basic Properties: Definition of a group -basic properties of a group-definition of Abelian group-isomorphic group-similarity transformation and classes-group multiplication tables-symmetry classification of molecules into point groups (Schoenflies symbol only) difference between point group and space group.

### UNIT-II

Definition of reducible and irreducible representations-irreducible representations as orthogonal vectors-direct product rule-the great orthogonality theorem and its consequences (statement only proof not needed)-determinations of the characters for irreducible representation of  $C_{2v}$  and  $C_{3v}$  point groups using the orthogonality theorem. Calculation of character values of reducible representations per unshifted atom for each type of symmetry operation (Character table may be provided to the students)-determination of total Cartesian representation—determination of direct sum from total Cartesian representation.

Group theory and vibrational spectroscopy-vibrational modes as basis for group representation symmetry selection rules for IR and Raman spectra (mutual exclusion principle)-classification of vibrational modes.

Application of group theory to chemical bonding

- Hybridization schemes for  $\sigma$  bonding in  $AB_4$  ( $T_d$ ) type (methane).
- Hybridization schemes for  $\pi$  bonding in  $AB_3$  ( $D_{3h}$ ) type (boron trichloride).

### UNIT III

Nanoscience

Nano: Definition, Introduction to nanoscale systems- History and current practice- Graphite to buckyballs to Carbon nanotubes (CNT). Single and Multiwalled CNT. Synthesis of – Nanotubes (Laser ablation, Electric Arc method, Catalytic Chemical Vapour Deposition-Homogeneous and heterogeneous including mechanism of growth -tip based root based), Functionalisation of nanotubes, Applications. Nanowires and nanorods (Template assisted synthesis- Pressure, Electrochemical, PVD, CVD and MOCVD methods, Template filling - Melt and solution filling, VLS method of growth, SLS method, Electrospinning).

### UNIT IV

Nanofabrication: Top-down approach – Nanolithography - Photo, Deep ultraviolet, X-ray, Electron beam, and Ion beam lithography. Soft lithography-micro contact printing, dip pen nanolithography. Bottom-up approach - STM/AFM atomic manipulation. Chemical method(Sol-gel synthesis).

Nano Characterization: SEM, TEM, SEM with EDX, Scanning probe microscopies (AFM and STM).

### UNIT-V

Introduction to computers and computation in chemistry

Basic structure and functioning of computers with PC as an illustrative example- memory. I/O devices secondary storage-computer languages-operating systems with DOS as an example-introduction to UNIX and WINDOWS-data processing, principle of programming- algorithms and flow charts. Data entry devices for sequential processing-data entry devices for direct access processing-data communication concepts: LAN, WAN, e-mail internet concept; computer virus; soft ware packages.

**REFERENCES:**

1. F.A.Cotton : Chemical applications of Group theory
2. M. Orchin and H.H. Jaffe : Symmetry, Orbital and spectra
3. G. Davidson : Introductory Group theory for Chemists
- 4 K.V. Raman : Computers in Chemistry
5. E. Balagurusamy and Deenadialu : Introduction to Computer
6. E. Balagurusamy : Programming in C
7. Jackie Ying - Nanostructured Materials, Academic Press; 1st edition, 2001.
8. Gregory L. Timp – Nanotechnology, American Institute of Physics; 1st edition, 1998.
9. Guozhong Cao – Nano structures and nano materials: Synthesis, properties and Applications- Imperial College Press (2004)
10. K. Eric Drexler- Engines of Creation. Anchor Books/Doubleday
11. K. Eric Drexler- Nanosystems: Molecular Machinery, Manufacturing, and Computation. John Wiley & Sons, Inc.: New York, 2001.
12. Robert A. Freitas Jr.- Kinematic Self-Replicating Machines. Landes Bioscience: Georgetown, TX. 2004
13. J. Storrs Hall, Nanofuture: What's Next For Nanotechnology, Prometheus Books, 2005.
14. NorioTaniguchi- Nanotechnology - Oxford University Press, 2005.

**Subject Title : PAPER IV ORGANIC CHEMISTRY – II**  
(Molecular rearrangements and Photochemistry)

**No.of hours: 75 hrs**

**Subject Description :**

This paper gives a concise idea of organic reaction mechanisms in molecular rearrangement and concerted reactions. In addition, mechanism in organic photochemical, oxidation- reduction reactions, addition reactions and stereoisomerism have been presented.

**Goals :**

To enable the students to learn different rearrangement reactions, pericyclic and name reactions in organic chemistry. A comprehensive knowledge on conformational analysis is also aimed.

**Objectives :**

On successful completion of the course the students should have: Mastered rearrangement reactions, Woodward-Hofmann rules, organic photochemistry, and synthetically important name reactions in organic chemistry and stereoisomerism in organic compounds.

## Contents

### UNIT-I

Molecular rearrangements: Introduction - Wagner - Meerwein rearrangements, Neber rearrangement, Baeyer —Villiger rearrangement. Rearrangements to electron deficient nitrogen and oxygen — Dienone phenol, Favorski, Fries, Wolf, Benzidine and Stevens rearrangements. Chapman, Neber, Arndt Eister Synthesis, Fischer Indole Synthesis, Schmidt rearrangement, Lossen and Wallach rearrangements.

### UNIT—II

Concerted reactions: Conservation of orbital symmetry – Woodward-Hoffman rules. Electrocyclic reactions – 1,3-dienes and 1,3,5-trienes. Analysis of reaction stereochemistry using correlation diagrams method and FMO method. Cycloadditions [2+2] and [4+2] – analysis using correlation diagram and FMO methods. Sigmatropic rearrangements – FMO method- Cope and Claisen rearrangements, di-pi-methane rearrangement. PMO Approach.

### UNIT-III

1. Organic photochemistry: Introductory theory of light absorption, photophysical processes – Jablonski diagram, energy transfer photochemical reaction of ketones - Norrish type I and type II reactions. Paterno – Buchi reaction and cis and trans isomerisation.

2. Oxidation and reductions: Mechanisms — oxidation of olefins, alcohols, glycols, ozonolysis and aromatization reaction and Sommelet reaction.

3. Reduction reactions and selectivity in reduction. Reduction reactions involving metal hydrides( $\text{LiAlH}_4$  and  $\text{NaBH}_4$ ). Reduction of nitro compounds, carbonyl compounds and aromatic compounds. Typical reactions such as Birch reduction, Clemmensen, Wolff – Kishner and MPV reduction.

### UNIT-IV

1. Addition reactions : Electrophilic and nucleophilic. Addition to double and triple bonds — Hydration. hydroxylation. Michael addition. hydroboration and epoxidation.

2. Addition to carbonyl compounds : Mannich reaction, Dieckmann, Stobbe, Knoevenagel, Darzen, Wittig, Thorpe and Benzoin reactions.

### UNIT - V

Stereoisomerism – Configurational & conformational isomerism:

1. Introduction, definition & classification. Molecular representation (Fischer projection, Newmann projection formula). Basic requirements of optical isomerism. Optical isomerism exhibited by a few nitrogen and sulphur compounds – the role of nitrogen inversion.

2. Configurational nomenclature: D & L, R & S and E & Z(olefins) nomenclatures.

3. Conformations of acyclic and cyclic molecules: Configurations and conformations of cyclohexane, mono and disubstituted cyclohexanes(conformational equilibrium –  $\Delta G$ ). Configurations and conformations of fused polycyclic systems – decalin, perhydrophenanthrene, perhydroanthracene. Stereoselective and stereospecific reactions.

## REFERENCES

1. Jerry March : Advanced organic chemistry
2. Jaffee and Drchin : Orbital symmetry

3. Entwistle : Orbital symmetry correlations in organic chemistry
4. Lehr and Marchand : Orbital symmetry
5. Pant De Mayo : Molecular rearrangements vol. 1 & II
6. N.J. Turro : Molecular photochemistry
7. C.H. Depuy and O.S. Chapman : Molecular reactions and photochemistry
8. J.M. Coxon and B.Halton : Organic chemistry
9. W.A. Pnyer : Introduction to free radical chemistry
10. S.M.Munergee and S.P.Singh : Reaction mechanisms in organic chemistry
11. L.N.Ferguson — The modern structural theory of organic chemistry
12. C.A.Bunten -- Nucleophilic substitution at the saturated carbon atom
13. J .Miller — Atomic nucleophilic substitution
14. C.K. Ingold — Structure and mechanism in organic chemistry
15. K.Milson — Introduction to stereochemistry
16. LL.Liel — Stereochemistry of carbon compounds
17. Whitaker David — Stereochemistry 18. Eliel and Ailsinger — Stereochemistry

**PAPER - V PHYSICAL CHEMISTRY -II**  
**(Quantum Chemistry and nanomaterials)**  
**No. of hours: 75 hrs**

**UNIT-I**

- 1.Success of quantum theory and the Failure of classical mechanics in explaining blackbody radiation, heat capacity of solids, photo-electric effect and the H-atom spectrum.(Derivation of Plank's distribution law and Einstein's heat capacity equation not needed). Heisenberg's uncertainty principle.
2. The time-dependent and time-independent schrodinger equations — Born's interpretation of the wave function. Requirements of the acceptable wave function. Postulates of quantum mechanics.
3. Algebra of operators. Sums and products of operators. Commutator. Linear operators. Eigen functions and eigen values. Correspondence between physical quantities in classical mechanics and operators in quantum mechanics. Hamiltonian operator. Angular momentum operator. Quantization of angular momentum and its spatial orientation. Average (expectation) values.

**Unit II**

1. Particle in a one—dimensional box. Quantization of energy. Normalization of wave function. Orthogonality of the particle in a one—dimensional box wave functions. Illustration of the uncertainty principle and correspondence principle with reference to the particle in a one dimensional box. Particle in a three-dimensional box. Separation of variables.
2. Solving of Schrodinger equation for the one—dimensional harmonic oscillator. Harmonic oscillator model of a diatomic molecule. Illustration of the uncertainty principle and correspondence principle with reference to harmonic oscillator.
3. Solving of Schrodinger equation for a rigid rotor. Rigid rotor model of a diatomic molecule.

### **UNIT-III**

1. Schrodinger equation for the H-atom (or H-like species) separation of variables (solving of radial equation is not needed but nature of solution is given), energy levels. Radial factors of the H-atom wave functions. Orbitals and orbital shapes. Probability density and radial distribution functions. The most probable distance of the H-atom (or H-like species) 1S electron.
2. Need for approximation methods. The perturbation theory (first order only). Application of the perturbation method to He-atom.
3. The variation method. Application of variation method to He-atom.

### **Unit IV**

Nano scale characterisation: Fundamentals of Nano-device measurements. Traditional surface and material analysis techniques- Raman, X-RD, SAXS, Measurements of Nano-devices and Atomic scale characterization – SEM/TEM, SEM with EDX, Scanning probe microscopies (AFM and STM). Chemical Characterization, Optical measuring systems-Surface Plasmon Resonance, pattern recognition and inspection systems.

### **UNIT V**

Applications of nano materials:

Biological applications- Polymeric nanomaterials for drug delivery, Hydroxyapatite.

Industrial applications - Nanorobots, Nano electro mechanical systems (NEMS). Computing - Present and future - Quantum methods of information processing.

Chemical Applications – Catalysis, Nanosensors, Nanomedicine-Domestic Applications- Self cleaning surfaces, Nano paints, water treatment, cosmetics. Environmental effects of nano.

### **REFERENCES:**

1. Ira.N.Levine, Allyn & Bacon IC : Quantum Chemistry, 1974
2. Mc. Quarie : Quantum Chemistry
3. Ira.N.Levine, McGraw : Physical Chemistry, Hill Book Company, 1971
4. Ira.N.Levine, Wiley : Interscience, N.Y. 1975
5. Jackie Ying - Nanostructured Materials, Academic Press; 1st edition, 2001.
6. Gregory L. Timp – Nanotechnology, American Institute of Physics; 1st edition, 1998.
7. Guozhong Cao – Nano structures and nano materials: Synthesis, properties and Applications- Imperial College Press (2004)
8. K. Eric Drexler- Engines of Creation. Anchor Books/Doubleday
9. K. Eric Drexler- Nanosystems: Molecular Machinery, Manufacturing, and Computation. John Wiley & Sons, Inc.: New York, 2001.
10. Robert A. Freitas Jr.- Kinematic Self-Replicating Machines. Landes Bioscience: Georgetown, TX. 2004
11. J. Storrs Hall, Nanofuture: What's Next For Nanotechnology, Prometheus Books, 2005.
12. NorioTaniguchi- Nanotechnology - Oxford University Press, 2005.

**Subject Title : PAPER VI - PHYSICAL METHODS IN CHEMISTRY - I**  
**No. of hours: 75 hrs**

**Subject Description :**

This paper presents the principles and applications of chromatography, crystallography, optical rotator dispersion, circular dichroism, turbidimetry, nephelometry, thermal analysis and principles of ESCA, AES, Mossbauer spectroscopy and ESR

**Goals :**

To enable the students the use of physical tools to understand structure of compounds.

**Objectives :**

On successful completion of the course the students should have:

Learnt physical techniques like ORD, CD, DTA, DSC, TGA, ESCA, GLC, HPLC,  
Understand the basis of massbauer spectroscopy, ESR and its applications.  
neutron and X – ray diffraction

**Contents**

**UNIT I:**

Chromatography – Principles, theory, instrumentation and applications in chemical analysis of the following – column, paper, thin layer and ion-exchange – GC, GLC and HPLC. Purification of common organic solvents.

Atomic absorption spectroscopy and Flame emission spectroscopy – basic principles – Instrumentation and applications.

**UNIT II**

Solid state and Chemical Crystallography – Diffraction methods – X-ray, neutron and electron Diffraction – Structure of NaCl, KCl and CsCl – Determination of lattice type and unit Cell dimensions – Power Camera – indexing the powder pattern – An elementary discussion of structural factors and scattering factor – Structures of rutile, fluorite, Antifluorite, zinc blende, wurtzite, diamond and graphite.

**UNIT – III**

Circular dichroism and optical rotatory dispersion-basic principles-basic principles of O.R.D. and C.D.-cotton effects-Octants rule-axial halo ketone rule application of O.R.D. and C.D.

Electron spectroscopy:

ESCA (XPS): principle, chemical shifts-description of SCA spectrometer, X-ray sources, samples analysis, detectors and recording devices-applications.

Auger electron spectroscopy (AES) and ultra-violet photo electron spectroscopy (UPS/PES)-principles and applications.

**UNIT IV**

Thermal analysis – Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC) – Basic principles.

Refractometry- Refractometer theory – basic principles – Abbey Refractometer – Applications.

Turbidimetry and Nephelometry-applications.

#### **UNIT – V**

Mossbauer Spectroscopy - principles – Spectrometer – Isomer shift – Quadruple interaction – Nuclear Zeeman Splitting – Applications

ESR Spectroscopy - theory – Derivative curves – ‘g’ shift – hyperfine splitting – Isotropic and anisotropic systems – Zero field splitting and Kramer degeneracy – Identification of free radicals – Applications.

#### **REFERENCES:**

1. A. I. Vogel : A text book of quantitative inorganic analysis
2. G. D. Christian : Analytical chemistry
3. D. A. Skoog and D. M. West : Fundamentals of Analytical Chemistry
4. D. A. Skoog : Instrumental methods of analysis
5. B. K. Sharma : Instrumental methods of analysis
6. H. H. Willard, L.L.Meritt, J.A. Dean: Instrumental methods of analysis
7. S.N.Khopkar : Fundamental concepts of Analytical Chemistry
8. Drago, Physical methods in Inorganic Chemistry
9. Djerassi, Optical Rotatory Dispersion
10. Chatwal, Instrumental Methods of Analysis
11. Sharma, Instrumental Methods of Chemical Analysis
12. Sharma, Chromatography
13. Arora, Solid State Chemistry
14. Alberty and Silbey, Solid State Chemistry

**Subject Title : PAPER VII ORGANIC CHEMISTRY - III**  
(Chemistry of Natural Products)

**No.of hours: 75 hrs**

#### **Subject Description :**

This paper deals with chemistry of natural products – terpenoids, steroids, alkaloids, proteins and heterocyclic compounds.

**Goals :**

To enable the students to know the chemical compositions of natural substances around them and to motivate them devise synthetic routes to prepare natural products in the laboratory.

**Objectives :**

On successful completion of the course the students should have:  
Understood the composition of the important natural materials around them.  
Learnt scientific methods to synthesise organic natural products.

**Contents :**

**UNIT-I**

Terpenoids: Isolation and classification of terpenoids — structural elucidation and synthesis of zingiberene, eudesmol, juvenile hormone, abietic acid and caryophyllene.

**UNIT-II**

Steroids: Introduction — structural elucidation of cholesterol (synthesis not required), ergosterol, equilenin, estrone, testosterone and progesterone.

**UNIT-III**

Alkaloids: Introduction – isolation of alkaloids, structural elucidation and synthesis of morphine, reserpine. Quinine, atropine and glaucine.

**UNIT-IV**

1. Proteins and nucleic acids: Classification and characteristics (structure) of proteins — synthesis of polypeptides and oxytocin, enzymes and coenzymes. Structure of RNA and DNA and their biological importance. 2. Heterocyclic compounds: Structure, synthesis and reactions of flavones, isoflavones, purines (adenine and guanine) and anthocyanins (cyanin and pelargonin).

**UNIT – V**

Reactions and reagents: Reactions in organic synthesis: Oppenauer oxidation, Barbier – Wieland degradation, Barton reaction, Jones oxidation and Vilsmeier reaction. Reagents in organic synthesis : Preparations and synthetic applications of DDQ(2,3-dichloro-5,6-dicyano-1,4-benzoquinone), DBU(1,5-diazabicyclo[5.4.0]undecene-5), DCC(dicyclohexylcarbodiimide) NBS, PCC, PDC and crown ethers.

**REFERENCES :**

1. J.L. Finar : Organic chemistry Vol. I & II
2. O.P. Agarwal : Natural product chemistry
- P.S. Kalsi : Chemistry of natural products
- R.K. Mackie and D.M. Sijnti : Guide book to organic synthesis
- J.N. Guntu and R. Kapoor : Organic reactions and reagents
- Acheson : Introduction to heterocyclic compounds
- Katritzky : Principles of heterocyclic chemistry
- S. W. Peijel Jez. : Alkaloids

**PAPER — VIII PHYSICAL CHEMISTRY — III**  
**(Thermodynamics)**

**No.of hours: 75 hrs**

**UNIT-I**

Thermodynamics and Non-ideal systems: Chemical potential and the definition of fugacity. Determination of fugacity of gases by graphical method and from equations of state. Variation of fugacity with temperature. Fugacity and the standard state for non-ideal gases. Definition of activity. Activity coefficient. Temperature coefficient of activity. Standard states. Applications of activity concept to solutions. The rational and practical approaches. Measurement of activity of solvent from colligative properties. Determination of activity of solute.

**UNIT-II**

Third Law of Thermodynamics: Probability and third law. Need for third law. Nernst heat theorem and other forms stating third law. Thermodynamic quantities at absolute zero. Statistical meaning of third law and apparent exception. Mathematical Introduction: Theories of permutation & combination, Laws of probability. Distribution laws. Gaussian distribution.

**UNIT-III**

Quantum statistics: Maxwell - Boltzmann statistics. Thermodynamic probability. Thermodynamic probabilities of systems in equilibrium. Boltzmann expression for entropy. Stirling's approximation. States of maximum thermodynamic probability. Lagrangian multipliers, thermodynamic probabilities of systems involving energy levels. Maxwell - Boltzmann distribution law. Evaluation of  $\alpha$  and  $\beta$  in M.B. distribution law.

**UNIT-IV**

Partition function: Partition function - definition, justification of nomenclature, microcanonical and canonical ensembles. Molecular partition function and canonical function. The relation between the total partition function of a molecule and the separate partition functions. 'Translational partition function, rotational partition function. Effect of molecular symmetry on rotational partition function. Ortho and para hydrogen. Vibrational partition function. Electronic partition function. Evaluation of thermodynamic properties  $E$ ,  $H$ ,  $S$ ,  $A$ ,  $G$ ,  $C_v$  and  $C_p$  from monoatomic and diatomic ideal gas molecule partition functions.

**UNIT-V**

Heat capacities of solids: Einstein's and Debye's theories of heat capacities of solids. Bose-Einstein and Fermi-Dirac Statistics: Bose-Einstein distribution law. Entropy of Bose-Einstein gas. Planck distribution law for black-body radiation. Fermi - Dirac distribution law. Entropy of a Fermi-Dirac gas.

**REFERENCES:**

1. Klotz : Chemical thermodynamics
2. P.W.Aikins : Physical chemistry
3. S. G lassione : Thermodynamics

4. M . C. Gupta : Statistical thermodynamics
5. Lee. Sears and Salinger : Statistical thermodynamics

## **PAPER-IX PHYSICAL METHODS IN CHEMISTRY II**

**No.of hours: 75 hrs**

### **UNIT - I**

Infrared Spectroscopy

Principle of infrared spectroscopy - description of double beam IR spectrophotometer-IR spectra of polyatomic molecules-factors affecting the vibrational frequencies-application of IR spectroscopy for organic and inorganic compounds-problems.

### **UNIT – II**

Ultraviolet and Visible Spectroscopy-Electronic spectra of diatomic molecules – Laws of photometry – Electronic absorption transitions – Correlation of electronic structure with molecular structure – Simple chromophoric groups – Effects of conjugation – Woodward – Fieser rules – Aromatic system and systems with extended conjugation – applications to organic and inorganic compounds – Instrumentation.

### **UNIT – III**

<sup>1</sup>H NMR Spectroscopy-magnetic properties of nuclei – theory of nuclear resonance – Chemical shift and its measurement – Factors influencing chemical shift – Chemical equivalence and magnetic equivalence – solvents and NMR spectra – Spin –Spin coupling – Spin-Spin splitting systems – Proton exchange reactions – Heteronuclear coupling – Deuterium exchange – Double resonances – Chemical shift reagents – Applications to organic and inorganic compounds - Instrumentation –CW and FT NMR

### **UNIT – IV**

<sup>13</sup>C NMR Spectroscopy- magnetic moment and natural abundance- broad band decoupling- deuterium coupling- NOE effect- Off-resonance decoupling- peak assignments using DEPT spectrum – structural applications of <sup>13</sup>C NMR spectroscopy.

Correlation NMR Spectroscopy- theory- <sup>1</sup>H-<sup>1</sup>H COSY, <sup>1</sup>H-<sup>13</sup>C COSY:

### **UNIT – V**

Mass Spectrometry-Theory – Instrumentation – Isotopic abundance – Determination of molecular weights and formulae, Ionisation techniques(CI, FD, FAB &ESI) – Nitrogen rule – Metastable ions and peaks – Ion fragmentation mechanisms – Retro Diels-Alder rearrangement – McLafferty rearrangement – Fragmentation associated with functional groups – aliphatic and aromatic compounds – Elimination due to ortho groups.

### **REFERENCES**

1. Drago, Physical Methods in Inorganic Chemistry
2. Silverstein, Basler and Morrill, Spectrometric identification of Organic Compounds
3. Kemp, Organic Spectroscopy

4. Kalsi, Spectroscopy of Organic Compounds
5. Banwell, Fundamentals of Spectroscopy
6. Das and James, Mass Spectrometry
7. McLafferty, Mass Spectrometry
8. Sheinmann, Introduction to Spectroscopic Methods
9. Pavia and Lampman, Introduction to Spectroscopy
10. Silverstein and Webster, Spectrometric Identification of Organic Compounds
11. Y. R. Sharma, Elementary Organic Absorption Spectroscopy
12. R. Chang, Basic Principles of Spectroscopy
13. B. Stuart, Infrared Spectroscopy: Fundamentals and Applications, John Wiley & Sons Ltd (2004)
14. Abraham and Lofters :  $^{13}\text{C}$  NMR spectroscopy

**Subject Title : Paper – X- INORGANIC CHEMISTRY – II**  
(Coordination Chemistry)

**No.of hours: 75 hrs**

**Subject Description :**

This paper presents basic principles of coordination chemistry and bioinorganic chemistry .

**Goals :**

To enable the students to learn some principles and theories in coordination, organometallic chemistry and bioinorganic chemistry .

**Objectives :**

On successful completion of the course the students should learn basic principles, important theories and applications of coordination chemistry.

**Contents**

**UNIT – I**

Crystal field theory – spectrochemical series – molecular orbital theory –comparison of MOT and CFT- $\pi$ - bonding – magnetic behaviour of the transition metal ions (Paramagnetic and diamagnetic properties, cooperative magnetism). Thermochemical correlation.

**UNIT – II**

Term symbols for the 3d-block elements and their ions – Orgel diagram ( $d^3$  and  $d^5$  only) – Tanabe-Sugano diagram for  $\text{Co}^{3+}$  system – John-Tellar distortions – spin-orbit coupling – Nephelauxetic effect – charge transfer spectra.-Racah parameters. Substitution reactions in square planar and octahedral complexes – trans effect – redox reactions (Inner and Outer sphere mechanism)

**UNIT – III**

d-Block metal carbonyls – Homoleptic carbonyls-Synthesis structure bonding and properties-Spectroscopic properties ( $^{13}\text{C}$  and IR) –Preparation, properties and structure of Iron carbonyls – Clusters-Preparation and Structure of  $\text{Fe}_2(\text{CO})_9$  and  $\text{Co}_4(\text{CO})_{12}$  –Isolobal analogies. Carbonyl hydrides and complexes of molecular nitrogen and oxygen (synthesis and reactions).

#### **UNIT – IV**

Cyclopentadienyl and related complexes – synthesis, bonding , structure and reactions.

Homogeneous catalysis by coordination compounds – hydroformylation using  $\text{Co}(\text{CO})_4\text{H}$ –  
Carboxylation of methanol – hydrogenation of alkenes (Wilkinson’s catalyst)-Wacker oxidation  
of alkenes-Alkene metathesis (Grubb’s catalyst)-Repe synthesis(Nickel based catalyst) -Vasca’s  
compound – Zeise salt.

#### **UNIT – V**

The Inorganic composition of cells- Sodium and potassium transport- Cytochromes (electron  
transfer)-Zinc enzymes(carbonic anhydrase) – Peroxidases-Oxidases-Oxygenases-  
Photosynthetic oxygen production-Nitrogen fixation (*in vivo* and *in vitro*). Hemoglobin –  
myoglobin - cyanocobalamin – chlorophyll (structure and functions). chelation therapy,  
antitumour agents - *cis*-platin.

#### **References**

1. Shriver and Atkins, Inorganic Chemistry, Fifth Edition.
2. Purcell and Cotz, Inorganic chemistry, , Fifth Edition.
3. James E. Huheey, Ellen A. Keiter and Richard L.Keiter : Inorganic Chemistry, IV Edn.,  
1993
4. Cotton and Wilkinson : Advanced inorganic Chemistry, Wiley Eastern (P), Ltd., 1968
5. H.J.Emeleus and A.G.Sharp : Modern aspects of Inorganic Chemistry, IV Edn., 1989
6. R.S.Drago : Physical methods in Inorganic Chemistry, 1978
7. R.C.Mehrotra and A.Singh : Organometallic Chemistry

#### **Subject Title : PAPER XI PHYSICAL CHEMISTRY – III** (Reaction Kinetics and Electrochemistry)

**No.of hours: 75 hrs**

#### **Subject Description :**

This course presents theories of reaction rates, comparison between reactions in different  
phases, catalysis, and theories of double layer and polarography.

#### **Goals :**

To enable the students to understand the kinetic aspects of chemical reactions and the role of  
catalysts on some specific reactions and the theories of double layers.

#### **Objectives :**

On successful completion of the course the students should have:  
understood the relation between different theories of reaction rate, study of reaction rate in solution, fast reaction and concept of homogeneous and heterogeneous catalysis  
learnt polarography, coulometric and amperometric methods of estimations.

### **Contents :**

#### **UNIT-I**

Theories of reaction rates: Arrhenius theory. Hard - sphere collision theory of gas – phase reactions. Activated complex theory or absolute reaction rate theory (ARRT) for ideal gas reactions (in terms of partition functions). Relation between activated - complex theory and hard - sphere collision theory. Thermodynamic formulations of activated complex theory & kinetic isotopic effect.

#### **UNIT-II**

1. Reactions in solution: Comparison between gas-phase and solution reactions. The influence of the solvent on the reactions between ions. Influence of ionic strength on rates of reactions in solution - Primary salt effect. Influence of pressure on rates of reactions in solution. Significance of volume and entropy of activations.
2. Study of Fast reactions: Flow methods, pulse methods, relaxation methods, Shock-tube method & nuclear magnetic resonance method.

#### **UNIT-III**

1. Homogeneous catalysis: Specific and general acid - base catalysis. Bronsted catalysis law. Hammett acidity function. Enzyme catalysis (single substrate reaction only). Michaelis-Menton law. Influence of pH and temperature on enzyme catalysis.
2. Surface phenomenon and heterogeneous catalysis: Adsorption and free energy relation at interfaces. Gibb's adsorption isotherm. Physisorption and chemisorption. Adsorption isotherms (Freundlich & Langmuir). Kinetics of heterogeneous catalysis. Langmuir - Hinshelwood and Langmuir - Rideal - Eley mechanisms.

#### **UNIT – IV**

1. Interionic attraction theory: Debye – Huckel – Onsager equation. Falkenhagen effect. Wien effect. Activity and activity coefficient. Ionic strength. Debye – Hukel limiting law and its applications.
2. Theories of double layer. Helmholtz – Perrin - Gouy chapmann – Stern theories.

#### **UNIT – V**

1. Polarography: Current – voltage relationships. The dropping mercury electrode. Diffusion current. Half – wave potentials. Applications of polarography. Amperometric titrations.
2. Fundamental principles of coulometric methods. Constant current and controlled potential methods. Simple applications.

#### **REFERENCES:**

1. K.J. Laidler : Chemical kinetics. Tata McGraw Hill
2. Gurdeep Raj : Chemical kinetics. Goel Publishing House

3. Puri, Sharma & Pathania : Principles of Physical Chemistry
4. A. A. Frost & R. G. Pearson : Kinetics and Mechanism. Wiley Eastern, Pvt
5. S. Glasstone : Introduction to electrochemistry.

### **Subject Title: Paper XII - POLYMER TECHNOLOGY**

**No.of hours: 75 hrs**

#### **Subject Description :**

This course presents additives used in plastics, fabrication process, fibre technology and elastomer technology.

#### **Goals :**

To enable the students to understand the fillers and their specific use in the end products of polymers, fabrication process and methods of making plastics, fibres and elastomers.

#### **Objectives :**

On successful completion of the course the students should have:  
understood plastic materials commonly used, their manufacture and compatibility of polymers and additives added to them,  
learnt the techniques of converting basic polymers into finished products.

#### **Contents**

##### **UNIT – I**

Plastic Technology: Production of ethenic polymers (polythene, PVC polyvinyl acetate, polyvinyl alcohol, polymethyl methacrylate. Polyacrylonitrile etc). Production of polycondensation polymers (phenol – formaldehyde, urea formaldehyde and epoxy resins).

##### **UNIT – II**

Polymer additives – use of fillers in plastics – degrading agencies and mechanism of degradation – antioxidants and other stabilizers – plasticizers – effect of plasticizers on polymer properties (Tg. Fluidity, mechanical properties and dielectric properties) – compatibility of plasticizers and polymers – theory of plasticization – use of flame retardants and colourants.

##### **UNIT – III**

Fabrication process – one-dimensional processes (application of coatings and adhesives) – two-dimensional processes (extrusion in general flat film, sheet and tubing) – three dimensional processes (injection moulding, foaming).

**UNIT-IV** Fibre technology: Production of natural and synthetic fibre, cellulosis fibres, polyamide fibres, polyester and acrylic fibres. Properties of textile fibres – criteria for fibre formation orientation of molecules on drawing.

Spinning processes – melt spinning- dry spinning and wet spinning.

##### **UNIT – V**

Elastomer technology: Synthetic rubbers, natural rubbers, butyl rubber, nitrile rubber and silicone rubber Vulcanization – chemistry of vulcanization (sulphur and nonsulphur vulcanization) – physical aspects of vulcanization accelerators – activators.

Reinforcement –Theories of reinforcement. Types of fillers – carbon black and non – black fillers.

## REFERENCES

1. F. Rodriguez : Principles of polymer science, TMH Edition, 1970
2. Dryden : Outlines of chemical technology, East West Press, 1965
3. L.K. Arnold : Introduction to plastics, George Allen Ltd. 1968
4. E.W. Duck : Plastics and rubbers, Butterworths, London, 1971
5. F.W. Billmeyer : Text books of polymer science, Wiley, Interscience 1971
6. K.K. Walczak : Formation of synthetic fibres
7. M. Morton : Introduction to rubber technology
8. W.C. Wake : The analysis of rubber and rubber-like polymers
9. C.V. Cagle : Hand-book of adhesive bonding, McGraw Hill
10. D.H. Kecalble : Physical chemistry of adhesion, Wiley-Interscience, 1971
11. R.M. Ogorikewiez : Thermoplastics – Properties and design, John Wiley
12. 1.1. Rublin : Injection moulding theory and practice, Wiley Inter science

## PRACTICAL SYLLABUS

### Practical – I Organic Chemistry – I

Analysis of two component – component mixtures. Separation and characterization of compounds.

About ten preparations involving one or two or three stages comprising of the following processes: Nitration, acylation, halogenation, diazotisation, rearrangement, hydrolysis, reduction, alkylation and oxidation and preparations illustrating the following:

Benzoin condensation, Cannizzaro reaction, Perkin reaction, Reimer-Tiemann reaction, Sandmeyer reaction, Fries rearrangement, Skraup synthesis.

Note: A minimum of six organic mixtures should be analysed by each student. A minimum of ten preparations involving one or two stages should be done by each student.

### Practical – II Inorganic Chemistry – I

Qualitative analysis, employing semimicro methods and spot tests of mixtures of common cations and ions of the following less familiar elements.

Thallium, Tungsten, Selenium, Tellurium, Molybdenum, Cerium, Thorium, Titanium, Zirconium, Vanadium, Beryllium, Uranium and Lithium.

About ten preparations involving different techniques selected from the following:

Lead tetra acetate, dipyridinium hexachloroplumbate, hydroxylamine hydrochloride, ortho-and para-hydroxy phenyl mercuric chloride, potassium cupric chloride, chrome alum, copper(I) chloride, trithio urea copper(I), potassium trioxalato-aluminato(III), potassium trioxalato chromate(III), potassium trioxalato ferrate(III), hexamine cobalt(III) chloride, chloro pentammine chromium(III), chloro aquo pentammine chromium(III) nitrate, tetrammine copper(II) sulphate, ammonium hexachloro stanate(IV).

Note: A minimum of six inorganic mixtures, each of two common and two rare elements should analysed by a student. A minimum of six preparations should be done by a student.

Colorimetric estimations (using Nessler technique and colorimeters) of copper, iron,

nickel, manganese, chromium and zirconium.

### **Practical – III Physical Chemistry – I**

Thermodynamics:

- a. Heat of solution from solubility
- b. Heat of solution by calorimetry

Molecular weight determination by

- i. Freezing point depression of solvents (benzene and water) by Beckmann method.
- ii. By Rast micro methods

Distribution of activity and activity co-efficients by freezing point method.

Distribution co-efficient and determination of equilibrium constant.

Properties of matter

Variation of viscosity of liquids with temperature.

Determination of refractive index (Unknown composition of a mixture of liquids).

Heterogeneous equilibria

Thermal analysis of binary systems forming compounds with congruent melting points.

Three component systems (chloroform-acetic acid-water).

Electromotive force

Determination of standard potentials (Cu, Zn, Ag)

Evaluation of thermodynamic quantities from e. m. f. data (Daniel cell).

Determination of PH and Pka values using hydrogen and quinhydrone electrodes and glass electrode (PH meter), potentiometric acid-base titrations.

Determination of formal redox potential of a redox system, redox titrations.

Determination of instability constant (of silver ammonia complex) and its dependence on temperature.

Determination of solubility product of a sparingly soluble salt (concentration cell and chemical cell).

Determination of activity co-efficients from e. m. f. data.

Precipitation titration of a mixture of halides.

### **Practical – IV Organic Chemistry – II**

Estimation of phenol, methyl ketone, glucose, nitro, amino and methoxy groups, unsaturation.

Analysis of oils (Reichert – Meissel value, Iodine value, Saponification value and acetyl value).

Extraction and estimation of active constituents:

- a. Lactose from milk
- b. Caffeine from tea
- c. Nicotine from tobacco extract
- d. Citric acid or ascorbic acid from a tablet or from a natural source.

About five preparations from literature.

### **Practical – V Inorganic Chemistry – II**

Industrial analysis: a. Analysis of two of the following alloys – brass, bronze, stainless steel, solder type metal. B. Analysis of any one of the following – cement, dolomite, glass.

Titrimetry: Oxidation using ceric and vanadium salts: Complexometric titrations involving estimation of calcium, magnesium, nickel, zinc and hardness of water.

Chromatography: Column, paper, thin layer and ion exchange.

Titration in non-aqueous solvents.

Preparation, analysis and study of the properties of co-ordination complexes.

Note: Quantitative analysis (involving volumetric and gravimetric estimations) of at least five mixtures of cations should be done by a student. The volumetric procedure may also include EDTA titration for estimation of mixtures of cations.

### **Practical –VI Physical Chemistry – II**

Conductivity experiments:

Determination of i) Equivalent conductance of a strong electrolyte and the verification of Debye-Huckel Onsagar law. ii) Verification of Ostwald dilution law and Kohlrausch law for weak electrolytes.

Conductometric determination of  $P_{ka}$  of a weak acid.

Hydrolysis constant of aniline hydrochloride.

Determination of the solubility of a sparingly soluble salt.

Conductometric titrations: Acid-base and precipitation titrations (including mixture of halides).

Colorimetric estimation using Beer-Lambert law (copper, nickel).

Dropping mercury cathodes – half-wave potentials and estimations by differential method of cadmium, copper, zinc and lead.

Chemical kinetics:

i. Evaluation of Arrhenius parameters using acid hydrolysis of an ester.

ii. Base catalysed hydrolysis of an ester conductometrically.

Rate of reaction between persulphate and iodide ions study of salt effects over the persulphate – iodide reaction.

Study of rate of polymerization of monomer solutions by viscosity.

Evaluation of i) Catalytic constant of a strong acid for the iodination of acetone or hydrolysis of an ester.

ii) Catalytic constants for weak acids and verification of Bronsted catalysis law.

Adsorption experiments: Adsorption of oxalic, acetic, formic acids on activated charcoal – Freundlich isotherm – surface area determination.

### **GROUP A: Elective PAPER I-DYE CHEMISTRY**

**No. of Hours: 45 hrs**

#### ***Unit I***

Colour and Constitution:

Relationship of colour observed to wavelength of light absorbed – Terms used in colour chemistry – chromophores, Auxochromes, Bathochromic shift, Hypsochromic shift. Quinonoid theory and modern theories: Valence bond theory, molecular orbital theory.

#### ***Unit II***

Chemistry of organic intermediates used in dye manufacture. Benzene, Naphthalene and Anthraquinone intermediates. Nitro dyes, Nitrosodyes, Azo dyes – principles governing azo coupling – mechanism of diazotization coupling with amines, coupling with phenols. Classification according to the number of azo groups and application – Tautomerism in azo dyes.

### **Unit III**

Synthesis of specific dyes and uses

Orange IV, Diamond Black F, Metanil yellow, Tartrazines Direct Deep Black, Eriochrome Black T, Eriochrome Red B, Cellitron Scarlet B, Congo Red, Malachite green, methylene blue, Safranin – T, Acid Magenta, Cyanin Green G, Alizarin, Benzanthrone, Indigo, Copper phthalocyanine, Sulphur black – T .

### **Unit IV**

Synthesis, reactions and applications of xanthene dyes, ‘Cyanine dyes, acridine dyes, Sulphur dyes, Anthraquinone dyes: Anthraquinone mordant dyes, Anthraquinone acid dyes and Anthraquinone disperse dyes.

### **Unit V**

Pigments – Introduction - Requirements of organic pigments Types of Pigments – Applications. Fluorescent. Brightening agents – application of dyes in other areas –  
Leather, paper, medicine, chemical analysis, cosmetics, colouring agents Food and Beverages

### **Reference books:**

1. Organic chemistry volume – I I.L. Finar
2. The chemistry of synthetic dyes volume I, III, III+IV K. Venkataraman.
3. Synthetic Dyes – Gurdeep R. Chatwal
4. An Introduction to synthetic drugs and dyes Ra. Chawathe. Shah.
5. An introduction to industrial chemistry B.K. Sharma.

## **GROUP C: Elective paper III Kinetics of polymerization**

### **UNIT-I**

Step polymerization: Theory of reactivity of large molecules, reactivity of functional groups and molecular size. kinetics of step polymerization, self catalysed polymerization, external catalysis of polymerizations. Cycization Vs linear polymerization, thermodynamic and kinetic consideration. Molecular weight control and distribution in Linear polymerization.

### **UNIT- II**

Kinetics of radical chain polymerization: Kinetic scheme for polymerization in the presence of an initiator. Thermal decomposition of initiators. redox initiation. Photochemical initiation, propagation and terminations — rate expression. Initiator efficiency, auto acceleration mechanism. Kinetics of chain transfer, chain transfer to monomer, initiation and solvents.

### **UNIT-III**

Ionic chain polymerization: Comparison of radical and ionic polymerizations. Cationic polymerization - initiation, propagation and termination - chain transfer to monomer spontaneous and backbiting. Kinetics expression and validity of steady state assumption.

The nature and mechanism of anionic polymerization, effect of monomers, initiators and solvents. Initiation, termination - polymerization without termination, termination by impurities and added transfer agents. Kinetics of polymerization with terminations.

#### **UNIT-IV**

Chain copolymerization Types of copolymers, evaluation of monomer reactivity ratio copolymer composition, the copolymer equation. Types — of copolymerization behaviour — ideal copolymerization, alternating copolymerization and block — copolymerizations. The Q-e scheme and rate of copolymerization — chemical controlled termination, diffusion controlled termination.

#### **UNIT-V**

Ziegler — Natta catalysis and polymerization: Definition Ziegler-Natta catalysts, chemical description of Ziegler-Natta catalysts for olefins, co-factors determining behaviour of catalysts. modification of Ziegler—Natta catalysts by third components, mechanisms for initiation and propagation mechanisms for stereochemical control of alpha—olefins. isotactic and syndiotactic propagation. Basic kinetics schemes and rate of polymerization.

#### **REFERENCES**

1. P.J. Flory : Principles of Polymer Chemistry, Cornell Unit, Press. New York, 1953
2. H.R. Allcock and F.W. Lampe : Contemporary Polymer Chemistry, Prentice Hall, Englewood, NJ, 1981
3. N.G. Gaylord and H.F. Mark : Linear and Stereoregular Addition Polymers, Wiley (Interscience), New York, 1959
4. F.W. Billmeyer : Jr. Textbook of Polymer Science, Wiley, New York, 1984
5. R.B. Seymour and C.E. Carraher : Polymer Chemistry, An Introduction Dekker, New York, 1981
6. T. Keii : Kinetics of Ziegler — Natta Polymerization; Chapman and Hall, 1972

#### **GROUP A: Elective Paper IV- Industrial Chemistry**

**No. of Hours: 45 hrs**

##### ***Unit I***

**Fuels:** Introduction – what is a fuel? – calorific value – classification of fuels properties of fuels – petroleum: classification of petroleum – Origin of petroleum – petroleum resources in India – Cracking of petroleum: Thermal cracking – catalytic cracking – knocking – chemical structure and knocking – octane rating. Improvement of anti-knocking characteristics of fuel. Non petroleum fuels. Benzol and power alcohol.

Nuclear fuels: Nuclear reactor, Breeder reactor Disposal of radio active wastes.

### ***Unit II***

Rubber: Importance of rubber – Coagulation of rubber – Draw backs of raw rubber – Rubber fabrication Vulcanisation – Properties of vulcanized rubber.

Synthetic rubber – Buna – s, Neoprene rubber, Buna – N, Thiokol, silicone rubber, Sponge rubber, Foam rubber

### ***Unit III***

Glass: Introduction – physical and chemical properties of glass –Raw materials – methods of manufacture: Formation of the Batch material, melting, shaping, Annealing and finishing.

Cement: Manufacture and setting of cement.

Ceramics: Manufacturing process – Application of clolurs to the pottery – Earthenware's and stonewares.

### ***Unit IV***

Paints and pigments;

Pigments: Introduction – Requirements of a pigment Typical inorganic pigments – Application.

Paints: Classification of paints – Distempers- constituents of paints – setting of the paint – Requirements of a good paint – Emulsion paints – Latex paints – paint removers – Varnishes – Solvents and thinners.

### ***Unit V***

Fertilizers: Plant nutrients – Fertilizers type – Essential requirements – Fertility of the soil – PH. value of the soil, classification of fertilizers, straight and mixed fertilizers. Nitrogenous fertilizers: Manufacture of Ammonium nitrate, Ammonium sulphate, Urea, nitrolim, CAN.

Phosphatic fertilizers: Normal superphosphate and triple superphosphate. Potassium fertilizers.

Explosives:

Introduction - Classification – Characteristics, Nitro Cellulose – TNB - TNT – Dynamite – Cordite, Gun Powder – RDX – HMX - Tetryl – Pentryl – Hexyl.

### **Reference Books:**

1. Industrial Chemistry – B. K. Sharma
2. Engineering Chemistry – Sharma
3. Engineering Chemistry - P.C. Jain & Monika Jain
4. Industrial Chemistry – B. N. Chakarbarty
5. Engineering Chemistry – Kuria Kose & Chemical technology – Shukla

### **GROUP A & B: ELECTIVE Paper II - Water Pollution and Industrial Effluents treatment**

No. of Hours: 45 hrs

#### ***Unit I***

Characteristics of water – Introduction – sources of water – Hardness of water - Units of hardness – problems on calculation of hardness – Disadvantages of hard water –

Scale and sludge formation in boiler – Boiler Corrosion - Softening methods – problems on softening – desalination of Brackish water: Distillation, Electro dialysis and reverse osmosis.

### ***Unit II***

Water Pollution: Introduction – Definition of water pollution – water  
Pollutants – physical and chemical pollution of water – ground water pollution – harmful  
effects of ground water pollution – surface water. River water and sea water pollution,  
Oil pollution of water. Effects oil pollution in marine water – Radioactive materials in  
water.

### ***Unit III***

Complete physico chemical Examination of water: collection of samples – colour – odour  
Turbidity  $P_H$  – temperature – Soilds: Total Solids, Dissolved solids, suspended solids, setttable  
solids – Acidity – Free carbon dioxide – Alkalinity – Hardness – calcium,  
Magnesium, Sodium - Potassium - Iron – Aluminum – Sulphate – Silica – Heavy metal such as  
Arsenic, Calcium, chromium – copper – lead - Manganese – Mercury – Nickle – Selenium – Tin  
and Zinc – Dissolved Oxygen, BOD, COD, Permanganate value – Ammonia Nitrogen –  
Albuminoidal nitrogen – Total Kjeldhal Nitrogen etc.

### ***Unit IV***

Industrial Effluents: Pulp and paper industries Cotton Processing – Cane sugar industry -  
Distillery –Dairy– Iron production. Electroplating industry – oil field and oil refinery – Fertilizer  
industry - Pesticide manufacture - Rubber wastes –Slaughter  
House and Meat packing – Soaps and Detergents manufacture - Soft Drinks Manufactures.  
Viscose rayon Manufacture – Radio active Pollution.

### ***Unit V***

Treatment of Industrial Effluents : Primary Treatment: Screening – Sedimentation – Equalization  
– Neutralization – Coagulation. Secondary Treatment: Aerated Lagoons – Trickling Filtration –  
Activated sludge process – Oxidation. Ditch – Oxidation Ponds - Anaerobic digestion. Tertiary  
Treatment : Evaporation – Reverse osmosis – Dialysis – Ion Exchange – chemical precipitation  
Activated Carbon Treatment. Tolerance limits for Industrial Effluents.

### **Reference Books**

1. Industrial Effluents – N. Manivasakam
2. Physico chemical Examination of Water, sewage and Industrial Effluents – N.  
Manivasakam
3. Water Pollution P.K .Goel
4. Engineering chemistry P.C. Jain & Monika Jain
5. Environmental Chemistry B. K. Sharma
6. Insecticides, Pesticides and Agro based Industries R.C. Falful, K. Goel , R.K.  
Gupta

## **GROUP B & C Elective Paper I -GREEN CHEMISTRY**

### **UNIT-I**

#### **Introduction to green chemistry:**

Green chemistry-relevance and goals, Anastas' twelve basic principles of green chemistry - Tools of green chemistry: alternative starting materials, reagents, catalysts, solvents and processes with suitable examples.

#### **UNIT-II**

##### **Microwave mediated organic synthesis (MAOS):**

Microwave activation – advantage of microwave exposure – specific effects of microwave – Neat reactions – solid supports reactions – Functional group transformations – condensations reactions – oxidations – reductions reactions – multi-component reactions.

#### **UNIT III**

##### **Ionic liquids and PTC**

Introduction – synthesis of ionic liquids – physical properties – applications in alkylation – hydroformylations – epoxidations – synthesis of ethers – Friedel-craft reactions – Diels-Alder reactions – Knoevengal condensations – Wittig reactions – Phase transfer catalyst - Synthesis – applications.

#### **UNIT IV**

##### **Supported catalysts and bio-catalysts for Green chemistry**

Introduction – the concept of atom economy – supported metal catalysts – mesoporous silicas – the use of Biocatalysts for green chemistry - modified bio catalysts – fermentations and biotransformations – fine chemicals by microbial fermentations – vitamins and amino acids – Baker's yeast mediated biotransformations– Bio-catalyst mediated Baeyer-Villiger reactions – Microbial polyester synthesis.

#### **UNIT V**

##### **Alternative synthesis, reagents and reaction conditions:**

A photochemical alternative to Friedel-crafts reactions - Dimethyl carbonate as a methylating agent – the design and applications of green oxidants – super critical carbon dioxide for synthetic chemistry.

#### **References:**

1. Green Chemistry – Environmentally benign reactions – V. K. Ahluwalia. Ane Books India (Publisher). (2006).
2. Green Chemistry – Designing Chemistry for the Environment – edited by Paul T. Anastas & Tracy C. Williamson. Second Edition, (1998).
3. Green Chemistry – Frontiers in benign chemical synthesis and processes- edited by Paul T. Anastas & Tracy C. Williamson. Oxford University Press, (1998).
4. Green Chemistry – Environment friendly alternatives- edited by Rashmi Sanghi & M. M. Srivastava, Narora Publishing House, (2003).

### **GROUP B : Elective Paper III - Medicinal Chemistry**

#### **Unit I**

Drugs: Introduction, Terminologies used in drug chemistry. Drugs and Diseases- diseases transmission. Common types of communicable diseases – Cholera, Malaria, Lymphatic Filariasis, Jaundice, Anaemia.

#### **Unit II**

Drug metabolism and action: Requirements of an ideal drug, drug metabolism, effect of age, species and strain difference, hereditary and genetic factors on drug metabolism, role of cytochromes in drug metabolism, The P-450 Catalytic Cycle, metabolic transformation of Halothane, Phase I-Non-synthetic reactions, Phase II-synthetic reactions,

### **Unit III**

Drug design and structure activity relationship: a general treatment of the approaches to drug designs, including the methods of variation, study of the use of biochemical and physiological information involving new drugs. Basic consideration of drug design – Denovo drug design – lead seeking methods, structural factors in drug design, physical and chemical factors in drug design.

### **Unit IV**

Quantitative Structure Activity Relationship (QSAR): Fundamentals of QSAR – objectives, expressions of biological activity, parameters related to chemical structure, correlative methods and analysis of results. A study of the SAR of important categories of drugs. Therapeutic targets for drug discovery.

### **Unit V**

Therapeutic agents: Antibiotics -  $\beta$ -lactam antibiotics, aminoglycosidal antibiotics, tetracyclines, chloramphenicol and antitumour antibiotics. Analgesic – Endogenous analgetic peptides, Opioid analgetic peptides and their simplified structures. Anti-inflammatory agents. Diuretics. Psychopharmacological drugs, Cardiac drugs, Antihypertensive agents, Cardiac glycosides, Anticancer agents. Antiviral agents.

### **Reference Books**

1. William Paul Purcell, George E. Bass, John Mark Clayton, Strategy of Drug Design, John Wiley & Sons Inc, 1973.
2. Wilson, Charles O. & Ole Gisvold, Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott publishers, 1962.
3. Graham L. Patrick- An Introduction to Medicinal Chemistry, Oxford University Press, USA; 3rd edition, 2005.
4. K. Bagavathi Sundari –Applied Chemistry, MJP Publishers, 2006.
5. Alfred Burger & Manfred E. Wolff, Burger's Medicinal Chemistry, John Wiley & Sons Inc; 4th edition, 1981.
6. E. J. Ariens- Drug Design, Academic Press 1980.
7. William O. Foye, Thomas L. Lemke, David A. Williams, Principles of Medicinal Chemistry, Williams & Wilkins; 4th edition, 1995.
8. H. John Smith, Smith and Williams' Introduction to the Principles of Drug Design and Action, Fourth Edition, CRC; 4th edition, 2004.
9. Stanley M. Roberts & R.F. Newton- Prostaglandins and Thromboxanes, Butterworth-Heinemann Ltd, 1982.
10. Jasjit S. Bindra & Ranjna Bindra- Prostaglandin Synthesis, Butterworth-Heinemann Ltd 1982.

## **GROUP B: ELECTIVE PAPER IV - APPLIED ELECTROCHEMISTRY**

**Subject description:**

It deals with the fundamentals principles of corrosion and its inhibition. It also deals with the measurement of corrosion by different techniques. Four important electroanalytical techniques widely employed in diagnostic and analytical divisions of industries have also been dealt with.

**Goals:** To make the students thorough with one of the leading problems threatening the economy of most of the industrialised nations and introduce to them some of the important electroanalytical tools.

**Objective:** On successful completion of the course the student should have: Understood principles of corrosion, corrosion monitoring and corrosion inhibition. Learnt electroanalytical techniques like cyclic voltammetry, anodic stripping voltammetry and electrogravimetry.

**Unit I** – Principles of corrosion Definition – cost of corrosion – importance of corrosion studies – classification of corrosion – expression for corrosion rates – Electrochemical principles of corrosion

**Unit II** – Corrosion monitoring Coupon (weight loss) method – electrical resistance method – gasometric method – potentiodynamic polarization method – impedance method – hydrogen permeation method

**Unit III** – Corrosion inhibition Inhibition – definition – importance – classification of inhibitors – based on electrode process – based on environment – mechanism of inhibitor action in acidic environment

**Unit IV** – Electroanalytical Techniques – I Cyclic voltammetry (CV)– theory – basic instrumentation – applications Anodic stripping voltammetry (ASV)– theory – basic instrumentation – applications.

**Unit V** - Electroanalytical Techniques – II Bulk electrolysis- electrogravimetry – controlled potential (potentiostatic) electrogravimetry – electroseparation – controlled current (coulostatic) electrogravimetry – current – time behaviour – comparative account of potentiostatic and coulostatic techniques

**Textbooks:**

1. An Introduction to metallic corrosion and its prevention by Raj Narayanan.
2. Vogel's Textbook of Quantitative Chemical Analysis by G.H. Jeffery, J. Bassett, J. Mendham, and R.C. Denney, Longman Scientific & Technical, 5<sup>th</sup> edition, 1989.

- References:**
1. Electrochemical methods – fundamentals and applications – Allen J. Bard and Larry R. Faulkner, Wiley International editions
  2. Electroanalytical chemistry – Basil H. Vassons and Galen W. Ewing, Wiley Interscience Publication 1983
  3. Chemistry Experiments for Instrumental methods – Donald T. Sawyer, William R. Heineman, Janice M. Beebe, John Wiley & Sons, 1984.

**GROUP C - ELECTIVE PAPER II - ADVANCED POLYMERIC MATERIALS**

**Subject description:** This paper gives a concise idea of the possible polymeric materials used in the most advanced areas of science and technology.

**Goals:** To enable students to learn different types of polymers and their composites used in controlled drug delivery, biosensors, conductivity, engineering, etc, their synthetic route and the current trends.

**Objective:** On successful completion of the course the student are ready: To choose any research work related to the advanced polymeric materials.

**Unit I** – Dendrimers and hyperbranched polymers Properties of Dendrimers and Hyperbranched Polymers and their Blends: Dendrimers and their structure, synthesis of Dendrimers, Hyperbranched Polymers and their structure. Synthesis of hyperbranched polymers, branching and polydispersity, conformation, general concepts of polymer blends. Blends of Dendritic polymers with thermoplastics.

**Unit II** – Polymer nano composites Polyamide/clay nano composites - Synthesis, characterization and properties of Nylon 6- clay hybrid. Polystyrene/clay nano composites – Surface initiated polymerization, syndiotactic polystyrene / clay nano composites, properties. Poly (butylenes terephthalate) (PBT) based nano composites, Epoxy nano composites on layered silicates. Polypropylene layered silicate nano composites.

**Unit III** – Synthetic Biomedical polymers for drug delivery Polymers as biomaterials, biomedical applications of synthetic polymers, synthetic polymers for biomedical applications, poly( $\alpha$ -hydroxy esters), poly (lactic acid), poly (anhydrides), poly (phosphazenes), controlled drug delivery, methods of drug delivery,

**Unit IV**– Conducting polymers Correlation of chemical structure and electrical conductivity. Structure of conducting polymers Poly (acetylene), poly (pyrrole)s, poly (thiophene)s, polyanilines, poly (p-phenylene sulphide), poly (p-phenylene vinylene)s. Different methods of synthesis of polyaniline: solution polymerization, interfacial polymerization, electrochemical synthesis, enzyme synthesis and photo induced polymerization of aniline. Applications of conducting polymers: Membranes and ion exchanger, corrosion protection, gas sensors, biosensors, electrocatalysis.

**Unit V**– Engineering plastics Acrylonitrile butadiene styrene (ABS), Polycarbonates (PC), Polyamides (PA), Polybutylene terephthalate (PBT), Polyethylene terephthalate (PET), Polyphenylene oxide (PPO), Poly sulphone (PSU), Polyether ether ketone (PEEK). Polyimides, Poly phenylene Sulphide (PPS), Synthetic route, structure, properties and uses.

**Textbooks:**

1. Advance polymeric materials Editors : Gabriel O. Shonaike & Suresh G. Advani, CRC press–2003

**References:**

1. Progress in preparation, processing and applications of polyaniline . Progress in polymer Science 34 (2009) 783 – 810
2. Monographs in electrochemistry Conducting polymers – a new era in electrochemistry Editor: F. Scholz Springer – Verlag, Germany
3. Polymer nano composites Editor: Y-W Mai, Wood head Publishing Ltd. 2006 M.Sc. Chemistry (Colleges) 2010-11

## **GROUP C - ELECTIVE PAPER IV - PHARMACEUTICAL CHEMISTRY**

### **Subject Description:**

This paper deals with the basic terminologies, common health problems to the human beings, different types of diseases and the suitable treatments.

### **Goals:**

To understand the types of diseases, their symptoms and the drugs used for curing them. Mechanism of action of drugs is also useful to develop new drugs.

### **Objectives:**

After completing, this study should help the students to compete during their search for jobs in the pharmaceutical companies.

### **Unit I – Introduction**

Important terminologies used in pharmaceutical chemistry – pharmacology – drug – pharmacophore – antimetabolites – mutation – Gram's test – actinomycetes – immunological agents – vaccines – toxoids – immune – human sera – primary immunization – routes of drug administration – additive effect – synergism – antagonism – placebo – important drugs which cause dependence – dosage – mechanism of drug action – factors influencing the metabolism of drugs – principles of bio assay – encapsulation – naming of drugs

### **Unit II – Medicinal plants and medicinally important compounds**

Indian medicinal plants – medicinal plants in cure of diseases – spices as medicines – medicinal plants in the kitchen garden – plant poisoning – medicinally important compounds of Mg, Al, P, As, Hg and Fe – testing cholesterol in serum – estimation of bilirubin in serum – estimation of urea in serum and estimation of inorganic chlorides in blood serum.

### **Unit III – Antibiotics and Sulpha drugs**

Antibiotics – penicillin – semisynthetic penicillin – chloramphenicol – streptomycin – cephalosporin – antifungals – nystatin – griseofluvin.

Sulpha drugs – sulphathiazole – sulphamerazine – sulphaguanidine – sulphadiazine – mechanism of action – uses.

### **Unit IV- Analgesics and Antipyretics**

Introduction to pharmaceutical chemistry analgesics – Morphine analogues and its modification – Codeine – Synthetic narcotic analgesics – Pethidines and methadones – Narcotic antagonists – Nalorphine – Antipyretic analgesics – pyrazoles – salicylic acid – paraaminophenol derivatives – Aspirin and salol hypnotics and sedatives – Barbiturates – Benzodiazepines.

### **Unit V – Antihypertensive, hypotensive drugs and antineoplastic drugs**

Antihypertensive and hypotensive drugs – mechanism of lowering blood pressure –  $\alpha$ -methyl dopa – pargyline – bertyline – hydralazine – propranolol and antiarrhythmic agents, anti tubercular drugs – PAS – INH – ethambutol, rifampicin – pyrazinamide.

Antineoplastic drugs – alkylating agents – nitrogen mustards – aziridines – sulphonic acid esters – 1,2 – epoxides – antimetabolites – folic acid and pyrimidine antagonists – vinca alkaloids – hormones – oral contraceptives.

### **Text & References:**

1. Berger, A medicinal chemistry, Wiley interscience, New York, Volume I and II, 1990.
2. Asutosh Kar, Medicinal chemistry, Wiley Eastern Ltd, Chennai, 1992.
3. Bentley and Driver's, Textbook of Pharmaceutical Chemistry, 1985.
4. Wilson, O. Giswold and F. George, Textbook of Organic medicinal and pharmaceutical chemistry, Philadelphia, 1991.

**GROUP A: ELECTIVE PAPER III**  
Organic Synthetic Methodology, Oxidation and Reduction

**UNIT I**

**Nomenclature** - IUPAC nomenclature of acyclic and monocyclic compounds-

Nomenclature of bicyclic system – large ring compounds (muscone, civetone) Novel ring system – adamantane – diadamantane, cubane (strained ring) catenane (interlocked system), bulvalene (fluxional molecule) (Synthesis not necessary)

**Reagents in Organic Synthesis** - Hexamethylphosphorictiamide (HMPT), Polyphosphoric acid (PPA), 1,3-dithiane (umpolung), Lithium dimethylcuprate (LDC), Lithium disopropylamide (LDA), crown ethers, Phase transfer catalysts (PTC).

**UNIT II**

**Synthetic Methodology** – Retrosynthesis – disconnection approach – synthons and synthetic equivalents – guidelines for choosing disconnections– linear and convergent synthesis - functional group interconversions – functional group addition-one group C-X disconnections – two group C-X bond disconnections – one group C-C bond disconnections – regioselectivity – two- group C-C bond disconnections - importance of the order of events – chemoselectivity – reversal of polarity. Protecting groups – protection of alcohols, carbonyl groups, carboxylic group and amino group.

**UNIT III**

**Oxidation** – Jone's reagent, Chromyl chloride, Dioxiranes, DMSO, DMSO-Ac<sub>2</sub>O, DMSO-oxalyl chloride (Swern reaction), Etard reaction, SeO<sub>2</sub>, Lemieux reagents (NaIO<sub>4</sub> with KMnO<sub>4</sub> & OsO<sub>4</sub>), allylic oxidation (SeO<sub>2</sub> & NBS), Fenton's reagent.oxidation of amines and sulphides, Wacker process (ketone from alkene) and ceric ammonium nitrate (CAN).

**UNIT IV**

**Reduction** –Metal hydride reduction – typical reactions and conditions used –NaCNBH<sub>3</sub> reductions, hydroboration, 9BBN, tri -n- butyl tinhydride ( TBH), DIBAL–H, Me<sub>3</sub>SiCN, tri tertiarybutoxy aluminum hydride. Dissolving metal reductions –Rosenmund reduction, McMurrays coupling, acyloin condensation, Wilkinson's catalyst, Bakers yeast.

**UNIT V**

Applications of UV, IR, <sup>1</sup>H NMR and Mass spectral techniques to solve the structures of simple organic molecules (simple problems based on data)

**REFERENCES**

1. Jerry March, Advanced Organic Chemistry
2. House, Modern Synthetic Reactions
3. Carruthers, Some Modern Methods of Organic Synthesis

4. Norman, Principles of Organic Synthesis
5. Pine, Organic Chemistry
6. Ireland, Organic Synthesis
7. Waren, Designing Organic Synthesis-A Programmed Introduction to Synthetic Approach
8. Furthrhop and Penzlin, Organic Synthesis Concepts, Methods and Starting Materials
9. Mackie and Smith, Guide lines to Organic Synthesis
10. Gurtu and Kapoor, Organic Reactions and Reagents.
11. Fieser and Fieser, Reagents in Organic Synthesis.
12. Jagdamba Singh and L.D.S. Yadav, Organic Synthesis
13. Silverstein, Bassler and Morrill, Spectrometric identification of Organic Compounds.
14. Kemp, Organic Spectroscopy
15. Kalsi, Spectroscopy of Organic Compounds.
16. Y. R. Sharma, Elementary Organic Absorption Spectroscopy
17. Silverstein and Webster, Spectrometric Identification of Organic Compounds.
18. S.C. Pal, Nomenclature of Organic Compounds