THE NATIONAL COLLEGE
AUTONOMOUS
JAYANAGAR, BANGALORE-560070

Accredited 'A' grade by NAAC

B.Sc.-Chemistry Syllabus
(From 2021-22Onwards)

॥ श्रद्धाहि परमा गतिः ॥

DEPARTMENT OFCHEMISTRY
THE NATIONAL COLLEGE
AUTONOMOUS
JAYANAGAR, Bangalore-560070

Chemistry Syllabus for B.Sc. / B.Sc. (Honors) Programme

Discipline Core: Chemistry **Total Credits for the Programme: 186**

Year of implementation: 2021-22 Programme Outcomes:

By the end of the programme the students will:

1. Understand the basic principles of various branches of Chemistry
2. Demonstrate a range of practical skills to conduct and infer experiments independently and in groups
3. Apply the key concepts and standard methodologies to solve problems related to Chemistry
4. Apply methodologies to the solution of unfamiliar types of problems
5. Exhibit skills leading to employability in Chemistry and allied industries
6. Comprehend the fundamental aspects of research in Chemistry
7. Possess the level of proficiency in subject required for post graduation as well as for pursuing research in Chemistry and related interdisciplinary subjects
8. Design solutions stemming from the application of Chemistry to the local issues

Title of the Course: DSC-1: Analytical and Organic Chemistry – I

Number of Theory Credits	Number of lecture hours/ semester
4	**56**

Content of Theory Course 1	56Hrs
Unit – 1	14 Hrs
Analytical Chemistry (Part-1): Definitions of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Choice of an analytical method - accuracy, precision, sensitivity, selectivity, method validation. Figures of merit of analytical methods and limit of detection (LOD), Limit of quantification (LOQ), linear dynamic range (working range). Errors and treatment of analytical data:Limitations of analytical methods – Errors: Determinate and indeterminate errors, absolute error, relative error, minimization of errors. Statistical treatment of finite samples -mean, median, range, standard deviation and variance. Acid-basetitrimetry: Titration curves for strong acid vs strong base, weak acid vs strong base and weak base vs strong acid titrations. Titration curves, Quantitative applications – selecting and standardizing a titrant, inorganic analysis - alkalinity, acidity.	7 Hrs
Analytical Chemistry (Part-2): Complexometric titrimetry: Indicators for EDTA titrations - theory of metal ion indicators, titration methods employing EDTA - direct, back, displacement and indirect determinations, Application-determination of hardness of water. Redox titrimetry: Balancing redox equations, calculation of the equilibrium constant of redox reactions, titration curves, Theory of redox indicators, calculation of standard potentials using Nernst equation. Applications. Precipitation titrimetry: Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate- Volhard's and Mohr's methods and their differences. Gravimetric Analysis: Requisites of precipitation, mechanism of precipitation, Factors influencing precipitation, Co-precipitation, post-precipitation, Advantages of organic reagents over inorganic reagents, reagents used in gravimetry (8-hydroxy quinoline (oxine) and dimethyl glyoxime (DMG). Numerical problems on all the above aspects.	7 Hrs
Unit - 2	14 Hrs
Classification and nomenclature of organic compounds, hybridization-types, shapes of organic molecules, influence of hybridization on bond properties.	
Nature of bonding in Organic molecules	
Types of chemical bonding, formation of covalent bond, notations used to represent electron movements and directions of reaction- curly arrows, formal charges. Types of bond breaking-homolytic and heterolytic. Types of reagents-Electrophiles, nucleophiles, nucleophilicity and basicity. Reactive intermediates :Carbocations, carbanions, free radicals, carbenes, nitrenes and benzyne.**Electronic displacement effects**: Inductive effects, Electromeric effect, Resonance effect, Hyperconjugation and steric effects, explanation with examples. **Types of Organic Reactions:** Substitution, addition, elimination, rearrangement and pericyclic reactions, explanation with examples. **Aliphatic Hydrocarbons:Alkanes**: *Preparation:* Corey-House synthesis, Wurtz reaction and Wurtz-Fittig reaction. Chemical properties (Free radical substitution, halogenation- relative reactivity and selectivity) and commercial importance. Difference between conformation and configuration. Conformations of ethane, propane and n-butane, explanation of stability based on energy profile diagrams. Nomenclature of nbutane conformations using Klyne-Prelog terminology. Conformation and stability of 1,2-	

dichloroethane, ethylene glycol and acetaldehyde. **Cycloalkanes:** Nomenclature, method of formation. Explanation for stability based on heat of hydrogenation data. Baeyer's strain theory and stability of cyclopropane. Conformations of cyclohexane (chair, twist boat, boat, half-chair and envelop forms and their stability). Geometrical isomerism with examples, *cis* and *trans* isomerism in 1,2dimethylcyclopropane and 1,2-dimethylcyclohexane.	
Unit - 3	14 Hrs
Carbon-carbon pi bonds **Alkenes**: Preparation by Wittig reaction-stereoselectivity, from but-2-yne to cis-alkenes – (partial catalytic hydrogenation) and trans-alkenes – (Birch reduction). Formation of alkenes by elimination reaction. Mechanism of E_1, E_2, E_1cB reaction. Saytzeff and Hofmann eliminations. Reactions: Addition of halogens to alkenes-carbocation and halonium ion mechanism. Stereospecificity of halogen addition. Addition of hydrogen halides to alkenes (Free radical addition of HBr to propene), mechanism, regioselectivity and relative rates of addition. Ozonolysis mechanism - ozonolysis of propene. Hydrogenation, hydration, hydroxylation and epoxidation of alkenes, explanation with examples. Diels-Alder reaction, allylic and benzylic bromination and mechanism in propene, 1-butene, 1-toluene and ethylbenzene. Conformation and stability of propene. Steric effect- Relative stability of trans and cis-2-butene. **Dienes:** Classification- isolated, conjugated and cumulated- one example. Structure of allene and butadiene. **Reactions:** 1, 2 addition and 1, 4 addition reactions. Diels Alder reaction: 1, 3-butadiene with maleic anhydride. **Alkynes**: Preparation*:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: alkylation of terminal alkynes and conversion to higher alkynes, and oxidation with hot alk. $KMnO_4$. Nucleophilic substitution:. Mechanism of S_N^1 and S_N^2 reactions with suitable examples. Energy profile diagrams, Stereochemistry and factors effecting S_N^1 and S_N^2 reactions	
Unit - 4	14 Hrs
Dilute solutions- Review of colligative properties and concentration terms Determination of molecular mass of a solute by: (i) Berkeley-Hartley's method ; (ii) Beckmann's method (ΔT^f) and (iii) Landsberger's method. Numerical problems **Distribution Law** Nernst Distribution Law – Statement. Distribution constant, factors affecting distribution constant, validity of Distribution Law, Modification of distribution law when molecules undergo a) Association b) Dissociation. Application of Distribution Law in Solvent extraction, numerical Problems **Solids** **Forms of solids:** Unit cell and space lattice, anisotropy of crystals, size and shape of crystals. Laws of Crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of symmetry (Symmetry elements), Crystal systems, Bravais lattice types and identification of lattice planes. Miller indices and its calculation, X–Ray diffraction by crystals: Bragg's law and derivation of Bragg's equation, Single crystal and powder diffraction methods. Defects in crystals, glasses and liquid crystals. Numerical problems.	

Text Books

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt.Ltd.(2007).

2. Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
3. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Organic Reaction mechanism by V. K. AhIuwalia and K. Parashar (Narosa Publishers).
5. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. (Narosa Publishers)

References

1.Finar, I. L. *Organic Chemistry (Volume I),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

2.McMurry, J. E. *Fundamentals of Organic Chemistry,* 7th Ed. Cengage Learning India Edition, 2013

Pedagogy :

Chalk and Talk, ICT Tools and Models

DCE-Lab-1 Analytical and Organic Practicals-1

Course Outcome:

After studying the course the student will be able to

1. Understand the safety practices in the Chemistry Laboratory
2. Develop awareness regarding toxicity of chemicals
3. Know the importance of calibration of glassware, pipette, burette and volumetric flask
4. Prepare standard/working solutions, standardization of solutions and determination of the respective analytes
5. Select suitablesolvent for purification of organic compounds
6. Gain an insight to the mechanism behind the reaction and the significance of catalysts
7. Learn the importance of green methods over conventional methods and proficiently handle the byproducts and disposal of waste
8. Enthuse students to conduct experiments by arousing the curiosity which would help them in learning basics and advanced concepts through simulation-based labs

List of Experiments to be conducted

PART-A Analytical Chemistry

1. Safety Practices in the Chemistry Laboratory, knowledge about common toxic chemicals and safety measures in their handling, cleaning and drying of glass wares.
2. Calibration of glassware, pipette, burette and volumetric flask.
3. Determination of sodium carbonate and sodium bicarbonate in a mixture.
4. Determination of alkali present in soaps/detergents
5. Determination of iron(II) using potassium dichromate
6. Determination of oxalic acid using potassium permanganate solution
7. Determination of Fe^{2+} as Fe_2O_3**Virtual Experiments**
8. Standardization of EDTA solution and determination of hardness of water
9. Gravimetric estimation of Barium
10. Gravimetric estimation of Nickel

PART-B Organic Chemistry

1. Selection of suitable solvents for Purification/Crystallization of organic compounds.
2. Preparation of acetanilide from aniline using Zn/acetic acid (Green method).
3. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture.
4. Hydrolysis of methyl m-nitrobenzoate to m-nitrobenzoic acid (Conventional method) 5.Synthesis of diazoaminobenzene from aniline (conventional method).
6. Preparation of dibenzalacetone (Green method).
7. Diels Alder reaction between furan and maleic acid (Green method). **Virtual Experiments**
8. Simple Distillation
9. Separation of Compounds by Column Chromatography
10. Detection of Functional Groups

Note:

1. Questions from both sections should be given in each batch.
2. In the first 20 minutes the Teacher should discuss in detail the theory, principle, procedure and calculations
3. Instructions to be given for operating instruments, weighing chemicals and precautions while handling chemicals
4. The last 20 minutes the teacher is expected to solve related problems based on the experiments.

Title of the Course: OE-1: CHEMISTRY IN DAILY LIFE Course Outcome:

After studying the course the student will be able to

1. Analyse the fat content and minerals in milk, butter and other dairy products
2. Know about various food preservatives, adulterants, additives and their analysis
3. Know about the Sources, role and deficiency symptoms of Vitamins
4. Learn the importance of renewable energy sources
5. Be aware of the applications of polymers as plastics in various fields and strategies for development of environment friendly polymers

Number of Theory Credits	Number of lecture hours/ semester
3	42

Content of Theory Course 1	42 Hrs
Unit – 1	14 Hrs
Dairy Products: Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk. Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages. **Food additives, adulterants, and contaminants**- Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate. **Artificial food colorants:** Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food.	
Unit - 2	14 Hrs
Vitamins: Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A1, Vitamin B1, Vitamin C, Vitamin D, Vitamin E & Vitamin K1.	
Oils and fats: Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Halphen test. **Soaps & Detergents**: Definition, classification, manufacturing of soaps and detergents, composition and uses	
Unit - 3	14 Hrs
Chemical and Renewable Energy Sources: Principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy storer. **Polymers:** Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronics, automobile components, medical fields and aerospace materials. Problems of plastic waste management. Strategies for the development of environment-friendly polymers.	

Text Books

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998)
2. Medicinal Chemistry- Ashtoush Kar.
3. Analysis of Foods – H.E. Cox: 13
4. Fred Billmeyer: Textbook of polymer science; Willey 3rd addition.

References

1.Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4thed. New Age International (1998)

2.Handbook on Fertilizer Technology by Swaminathan and Goswamy, 6th ed. 2001, FAI.

Semester 2

Title of the Course: DSC – 2: INORGANIC AND PHYSICAL CHEMISTRY– I

Number of Theory Credits	Number of lecture hours per semester
4	56

Content of Theory Course 2	56Hrs
Unit – 1	14 Hrs
Atomic structure Bohr's theory and its limitations and atomic spectrum of hydrogen atom. Need of a new approach to atomic structure. Wave mechanics: de Broglie equation, Problems on calculation of wavelength of an electron Heisenberg's Uncertainty Principle and its significance What is Quantum Mechanics? Sinusoidal wave equation (Explain sinusoidal wave, Classical wave mechanics). Schrodinger's wave equation – derivation. Applications of Schrodinger's equation to the hydrogen atom. significance of ψ and $\psi 2$ Postulates of quantum mechanics. Hamiltonian operator. Eigen values and function. Concept of orbitals, Radial and angular parts of the hydrogenic wave function (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (graphical representation only). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Quantum numbers: Significance of quantum numbers. The four types of quantum numbers, shapes, s, p and d atomic orbitals, discovery of spin, spin quantum numbers (s) and magnetic spin quantum number (ms). Electronic configuration of elements. Principles (Aufbau, Pauli's exclusion principle and Hund's rule). Stability of half-filled and completely filled orbitals. Relative energies of atomic orbitals, Anomalous electronic configurations.	
Unit - 2	14 Hrs
Periodic Table & Periodic Properties The long form of periodic table. Classification of elements in to s, p, d and f-block elements. Periodic properties & trends in the periodic properties with reference to s and pblock elements: (a) Atomic radii (van der Waals) (b) Ionic and crystal radii. (c) Covalent radii (d) Ionization enthalpy, successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (e) Electron gain enthalpy, trends of electron gain enthalpy. (f) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Trends in the periodic properties. Applications in predicting and explaining chemical	

behaviour. Trends in the Chemistry of the compounds of groups 13 to 17 (hydrides, carbides, oxides and halides).	

Unit - 3	14 Hrs
Gaseous State Elementary aspects of kinetic theory of gases, Ideal and real gases. Boyle temperature (derivation not required), Molecular velocity, collision frequency, collision diameter, Collision cross section, collision number and mean free path and coefficient of viscosity, calculation of σ and η , variation of viscosity with temperature and pressure. Maxwell's Boltzmann distribution law of molecular velocities (Most probable, average and root mean square velocities). Relation between RMS, average and most probable velocity and average kinetic energies. (Mathematical derivation not required), law of equipartition of energy. Behaviour of real gases: Deviation from ideal gas behaviour. Compressibility factor (Z) and its variation with pressure for different gases. Causes of deviation from ideal behaviour, vanderWaals equation of state (no derivation) and application in explaining real gas behaviour. Critical phenomena - Andrews isotherms of CO_2, critical constants and their calculation from van der Waals equation, Continuity of states, Law of corresponding states. Numerical problems. **Liquid State** **Surface Tension**: Definition and its determination using stalagmometer, effect of temperature and solute on surface tension **Viscosity**: Definition, Coefficient of viscosity. Determination of viscosity of a liquid using Oswald viscometer. Effect of temperature, size, weight, shape of molecules and intermolecular forces. **Refraction**: Specific and molar refraction- definition and advantages. Determination of refractive index by Abbes Refractometer. Additive and constitutive properties. **Parachor:** Definition, Atomic and structure parachor, Elucidation of structure of benzene and benzoquinone. Viscosity and molecular structure. Molar refraction and chemical constitution. Numerical Problems.	

Unit - 4	14 Hrs
Arenes: Nomenclature: mono, di and tri substituted benzenes, aromaticity: Huckel's rule application to benzenoid (benzene, naphthalene, anthracene and phenanthrene) and nonbenzenoid (cyclopropenyl cation, cyclopentadienyl anion, tropylium cation) compounds, anti-aromaticity, homoaromaticity. Benzene: molecular orbital picture and resonance energy. Preparation-from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Aromatic Electrophilic substitution reactions, mechanisms, σ and π complexes, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence, Ortho-para ratio. Aromatic nucleophilic substitution reaction: S_N^{Ar} and Benzyne mechanism with suitable examples, Birch reduction, side chain oxidation of toluene to benzaldehyde and benzoic acid. Polynuclear hydrocarbons: naphthalene, anthracene and phenanthrene- Preparations, resonance structures, oxidation of naphthalene, anthracene and phenanthrene. Electrophilic and nucleophilic substitution reactions of naphthalene and anthracene. Diels-Alder reaction of anthracene with 1,2-dichloroethene. Alkenyl benzenes: Styrene, *cis*- and *trans*-stilbenes and their preparations. Biphenyl: Preparation-Ullmann reaction.	

Text Books

1. Concise Inorganic Chemistry: J D Lee, 4thEdn, Wiley, (2021)
2. Atkins Physical Chemistry.8th Edition. Peter Atkins & Julio De Paula Oxford University Press.
3. Principles of Physical Chemistry, Puri, Sharma &Pathania, Vishal Publishing Co.
4. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House (2018) **References**

1. Basic Inorganic Chemistry, F A Cotton, G Wilkinson and P. L. Gaus, 3rd Edition. Wiley. India
2. Physical Chemistry by Samuel Glasstone, ELBS (1982).
3. A Text Book of Physical Chemistry P.L.Soni , O.P. Dharmarhaand andU.N.Dash, Sultan Chand and Sons.

DSC LAB-2: Inorganic and Physical Practicals

Number of practical Credits	Number of practical hours per semester
2	56

Tutorials
Green Principles to be adopted in the laboratories
Specific arrangements to be made for disposal of chemicals and solutions after the experiments
Calibration of instruments, glasswares etc to be performed in the beginning of the experiments
Preparation of Standard solution along with calculations to be taught
Handling and dilution of mineral acids to be emphasized
Selection and usage of Indicators to be explained

List of Experiments to be conducted

PART-A Inorganic Chemistry TITRIMETRY

1. Determination of carbonate and hydroxide present in a mixture.
2. Determination of oxalic acid and sodium oxalate in a given mixture using standard $KMnO_4$/NaOH solution
3. Standardization of potassium permanganate solution and determination of nitrite in a water sample
4. Determination of alkali content in antacids
5. Determination of chlorine in bleaching powder using iodometric method.

Virtual Experiments

6. Determination of concentration of Potassium Permanganate solution using Ferrous Ammonium sulphate
7. Standardization of silver nitrate and determination of chloride in a water sample
8. Soil Analysis-Determination of pH of soil.

PART-B Physical Chemistry

1. Determination of density using specific gravity bottle and viscosity of liquids using Ostwald's viscometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids)
2. Study of the variation of viscosity of sucrose solution with the concentration of a solute
3. Determination of the density using specific gravity bottle and surface tension of liquids using Stalagmometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids)
4. Study of variation of surface tension of detergent solution with concentration.
5. Determination of molar mass of non-electrolyte by Walker-Lumsden method
6. Determination of partition/distribution coefficient of Benzoic acid in water and toluene
7. Determination of compositionof liquid mixtures by refractometry. (toluene and alcohol, water and sucrose)
8. Determination of specific and molar refraction by Abbes refractometer (ethyl acetate, methyl acetate, ethylene dichloride)

Virtual Experiments

9. Determination of molar mass of a non-volatile solute by cryoscopic method
10. Determination of viscosity by average molecular weight of a polymer
11. Determination of partition co-efficient of Iodine between water and carbon tetrachloride ***Note:***

1. Questions from both sections should be given in each batch.
2. In the first 20 minutes the Teacher should discuss in detail the theory, principle, procedure and calculations
3. Instructions to be given for operating instruments, weighing chemicals and precautions while handling chemicals
4. The last 20 minutes the teacher is expected to solve related problems based on the experiments.

Title of the Course: OE – 2: Molecules of Life

Content of Theory Course 2	**42 Hrs**
Unit – 1	14 Hrs
Carbohydrates Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structures. Epimers, mutarotation and anomers. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation. Carbohydrates as a source of energy **Amino Acids, Peptides and Proteins** Classification ofamino acids, Zwitterions structure and Isoelectric point. Peptides: structure and conformation, example and function of biologically important Peptides. Proteins: Classification of proteins with examples. Primary, Secondary, Tertiary and Quaternary structure of proteins. Importance of primary structure by taking sickle cell anemia as an example. Denaturation of proteins:, Renaturation of proteins.	
Unit - 2	14 Hrs
Enzymes and correlation with drug action Brief introduction, Nomenclature (E.C. No. upto 2nd digit) and classification of enzymes, Effect of pH and temperature. Enzyme specificity and theories-Lock and key model, induced fit theory. Active site and its characteristics, Mechanism of enzyme action, factors affecting enzyme action, Co-enzymes and cofactors and their role in biological reactions. Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Noncompetitive inhibition including allosteric inhibition). **Drug action**-receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group, -NH_2 group, double bond and aromatic ring. **Lipids** Introduction to lipids, classification. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats,Hydrogenation, Rancidity of oils. Triglycerides:: Biological importance of triglycerides. Saponification, saponification value and its significance, Unsaturation in acyl glycerols- iodine number and iodine number of different oils.Prostaglandins: definition and example, biological role of prostaglandins in general, Waxes: definition, types, biological importance. Lipoproteins: Types and functions, clinical	

significance.	
Unit - 3	14Hrs
Nucleic Acids Components of nucleic acids: Adenine, guanine, thymine and cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides **(nomenclature**), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (**types of RNA**), Genetic Code, -(general features and about Central dogma of Molecular biology) Biological importance of DNA and RNA: Replication, Transcription and Translation. Physico- chemical properties of DNA - effect of alkali, acid and heat (denaturation and renaturation), Mutation; Mutagens- chemical and physical, Molecular basis of mutation: spontaneous and induced mutations. **Concept of Energy in Bio systems** Introduction to bioenergetics, stages of energy transformations – Photosynthesis respiration and utilization of energy. Exergonic and endergonic reactions. Standard free energy change. Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Energy yield of Carbohydrates, Fats, Lipids and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.	

Text Books

1.Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2.A Text BookofBioChemistry, V. S. S. Rama Rao, UBSPD,1998.

References

1.Concise Text Book ofBioChemistry,T. N. Pattabhiraman, All India Publishers, 2000.

2.W. H. Freeman. Berg, J.M., Tymoczko, J.L. &Stryer, L. *BioChemistry*, , 2002.

Semester – III

PAPER – III

52 Hours

UNIT – I

Chapter-1:Chemical Kinetics 7 Hours

Chemical Kinetics and its scope, rate of a reaction factors affecting the rate of a reaction concentration temperature, pressure, solvent, light and catalyst. Molecularity and order of reactions. Mathematical expression of simple reactions-zero order, first order, second order. Derivation of expression for the rate constant of a second order reaction with a=b and a≠b. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned Problems on rate constant half-life period, mean life period and order of reaction. Determination of order of reaction. Differential method, method of integration method of integration, method of half-life period and isolation method. Theories of reaction rates: effect of temperature on rate of reaction. Arrhenius equation concept of activation energy. Problems, simple collisions theory based on the hard sphere model, transition state theory(equilibrium hypothesis) Expression for the rate constant based on equilibrium constant and thermodynamics aspects, steady state approximation and Lindemann's hypothesis, experimental determination of kinetics of(i)inversion of canesugar by polarimetric method. (ii) Spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

Chapter 2: Solid State Chemistry 6 Hours

Definition of space lattice, unit cell, laws of crystallography. Symmetry elements in crystals, seven crystal systems, Weiss and miller indices Derivation of Bragg's equation. Problems on interplanar distance and density. Determination of structure of NaCl and KCl by rotating crystal method. Structure of ionic solids based on radius ratio (Calculation not required) crystal coordination number. Structures of NaCl, CsCl, ZnS, CaF_2 and $CaTiO_3$ crystals. Schottky and Frenkel defects (Causes for defects in solids to be mentioned qualitatively in terms of free energy and entropy concepts) variation properties due to defects to be mentioned. F-center(to be explained with respect to trapping of electrons in the lattice of NaCl and KCl crystals). Gemstones (to be explained with reference to substituting of transition metal ion in Al_2O_3) Non stoichiometric compounds (Feo, transition metal hydrides). Liquid crystals-classification, structure and applications.

UNIT – II

Chapter 3: Gases 8 Hours

Introduction: Maxwell-Boltzmann distribution law, mathematical expression for both mole and molecule explanation of the terms only. Explanation of velocity distribution curve based on this law (no derivation) mean free path, collision frequency and collision number, derivation of expression for most (probable velocity from Maxwell-Boltzmann equation. Definitions and expressions for rms velocity and the average velocity, relationships among them.Problems on velocity using SI units.

Andrews isotherm on CO_2 and explanation of curves. Derivation of critical constant Tc, Pc and Vc from Vander Waals equation and their experimental determination by Cagniard de Law Tour method for Tc and Pc, Amagat's mean density for Vc. Problems on the calculation of Tc, Pc and Vc, a and b.

Law of corresponding state: statements reduced equation of state and explanation, joule Thomson co-effect - explanation. Joule Thomson co-efficient. Inversion temperature-definition (no derivation). Application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

Chapter 4: Polymer Chemistry **5 Hours**

Introduction: Polymerisation, types- addition and condensation polymerization.Molecular weight of polymers, weight average and number average method.(Experimental determination is not required)

Preparation and applications of the following types of polymer.

1. Plastics: i) Thermosetting plastics (phenol- formaldehyde)
   ii) Thermosoftening plastics (PVC)
2. Fibres: Acrylic polyamide, polyesters types- one example for each.
3. Rubber: Neoprene
4. Fluorocarbons: Teflon
5. Silicones

UNIT – III

Chapter5: General study of d and f block elements **6 Hours**

Transition elements: Electronic configuration, atomic and ionic sizes, Lanthanide contraction and its consequences. Oxidation states, magnetic, spectral properties and formationand complexes. Comparison of oxidation states, complex formation and magnetic proper and f block elements. Ion-exchange method of separation of lanthanides.

Chapter 6: Metallurgy **4 Hours**

Ellingham's diagram: Salient features, selection of reducing agents using Ellingham's diagram. Extraction of i) Nickel from Pentlandite ore ii) Thorium from monazite sand iii) Uranium from pitch blende and iv) Plutonium from nuclear waste.

Chapter 7: Powder Metallurgy **3 Hours**

Advantages of powder metallurgy, applications. Method of production of metal powders. Production of tungsten powder from Wolframite.

UNIT – IV

Chapter 8: Alcohols and Thiols **5 Hours**

Alcohols: introduction, Methods of preparation.

i) From carbonyl compounds- reduction of aldehydes and ketones (by Meerwein - Pondoroff verily reaction)
ii) From acids and esters (by reaction with $LiAlH_4$)
iii) From alkene (by hydroboration-oxidation with alkaline peroxide.
iv) Hydration of alkenes, reaction of alcohols, acidic nature esterification, oxidation of alcohol using $KMnO_4$, comparison of reactivity of 1^o, 2^o, 3^o alcohols - Lucas test, oxidation with $K_2Cr_2O_7$.

Glycols: Preparation from alkenes using OsO_4 and $KMnO_4$ and from epoxides. Oxidation of glycols by periodic acid and tetra acetate with mechanism, Pinacol-pinacolone rearrangement.

Glycerol: Preparation from propene and from oils/fats uses. Reaction of glycerols

i) Nitration
ii) Action of concentrated H_2SO_4
iii) Oxidation by Periodic acid

Thiols: Methods of formation and chemical reaction of methane thiol (with Sodium, NaOH, Metal oxide, formation of Thioesters and oxidation with mild and strong oxidizing agents) uses of Dithianes. Introduction of umpolung character in carbonyl compounds.

Chapter 9: Phenols **3 Hours**

Classification, Acidic nature, comparison of acidic strength of phenol with alcohols and mono carboxylic acids. Effect of electron with drawing-NO_2 group and electron donating-CH_3 group on acidity of phenols at o, m and p-positions, Pechmann reaction, mechanisms of Reimer Tiemann and Kolbe-Schimdt reaction. Industrial applications of phenol.

Conversion of phenol to (i) Aspirin ii) Methyl salicylate

(iii) Salol (iv) Salicylsalicyclic acid.

Chapter 10: Ethers and Epoxides **3 Hours**

Ethers: Methods of preparation i) dehydration of alcohols, ii) Williamson's ether synthesis. Reactions-ethers as Lewis bases (Complexation with metal ions) cleavage and auto oxidation, Ziesel's method.

Epoxides: Preparation using per acids, Darzen's reaction of mono and 1, 2-disubstitued epoxides with (i) carbon nucleophiles (ii) nitrogen nucleophiles (iii) reaction with $LiAlH_4$.

Chapter 11: OrganoMetallic Compounds **3 Hours**

Preparation and synthetic applications of Grignard reagents: Preparation of methyl magnesium iodide, Applications in the synthesis of ethanol, acetic acid, acetaldehyde and acetone from methyl magnesium iodide.

Organo lithium compounds: Preparation from methyl iodide and synthetic application preparation of methane and ethanoic acid. Lithium dialkylcuprates-preparation from methyl iodide.

****

Semester – IV

PAPER – IV

52 Hours

UNIT – I

Chapter-1:Phase Equilibria **7 Hours**

Significance of phase rule. Definition of phase rule. Statement and explanation of terms with example for phase (P), Component (C) and degree of freedom (F), F=C-P+2. One component systems: water and Sulphur. Two components systems-modified form of phase rule. Water potassium iodide, lead-silver, Zn-Mg and Naci -H20. Eutectic mixtures and their applications. (example: Freezing mixtures, desilverisation of lead by Pattinson's process).

Chapter 2: Surface Chemistry **5 hours**

Adsorption: Review of types of adsorption and factors affecting adsorption. Freundlich Adsorption and Langmuir's adsorption isotherm. (derivation of Langmuir's isotherm). BET equation (derivation not required), applications of adsorption.

Catalysis: Characteristics, catalytic inhibition, catalytic poisoning. Types of catalysis homogeneous and heterogeneous catalysis with examples. Mechanisms of catalysis (intermediate compound theory and adsorption theory).

Homogeneous catalysis: Acid-base catalysis: Enzyme catalysis.

Heterogeneous catalysis: Surface reactions, unimolecular, bi molecular surface reactions. Autocatalysis and oscillating reactions.

Chapter 3: Water Technology **5 hours**

Types of impurities present in water, causes for hardness of water, permissible levels of ions present in water. Treatment of water for domestic and industrial purposes (i) by reverse osmosis method, (ii) by ion exchange method.

UNIT – II

Chapter 4: Analytical Chemistry **6 hours**

a. Organic reagents in inorganic analysis-Advantages and uses of:
b. EDTA in the estimation of calcium (Volumetry)
c. Oxine in the estimation of magnesium (gravimetry)
d. DMG in the estimation of nickel (gravimetry)
e. Ortho-phenanthroline in the estimation of iron (Colorimetry)
f. Electrogravimetric estimation of copper, flame photometric determination of sodium and potassium.

Chapter 5: Nuclear and Radiochemistry **7 hours**

Nucleus-Structure and instability, binding energy calculations, radioactive decay law, half-life, radioactive equilibrium, radioactive series. Artificial radioactivity-nuclear reactions induced by ϒ-radiation α, n, p and-particles, disposal of radioactive wastes. Nuclear fission and fusion. Nuclear reactors, Breeder reactors, atomic energy programme in India. Isotopes-use of radio-isotopes in tracer technique, agriculture, medicine, food preservation Numerical problems.

UNIT – III

Chapter 6: Powder Metallurgy 3 hours

Advantage of powder metallurgy, applications. Method of production of metal powders. Production of tungsten powder from Wolframite.

Chapter 7: Steel 7 hours

Iron-carbon phase diagram; Austenite, ferrite, cementite and pearlite phases.

Alloy steels-influence of Si, Mn, Cr, Ni, Ti and W on the properties of steel.

Ferro Alloys- production of ferrochrome, ferromanganese and ferrosilicon and their applications.

Carbon Steel-classification. Heat treatment-and hardening, carbiding, nitriding, tempering and annealing.

Chapter 8: Environment Chemistry 4 hours

Earth's atmosphere: Depletion of ozone layer in the stratosphere. Causes and remedial measures. The green-house effect and its consequences. Acid rain, photochemical smog. Treatment of sewage and industrial effluents. Green chemistry: principles.

UNIT – IV

Chapter 9: Aldehydes and Ketones 5 hours

General methods of preparation: Aldehydes from acid chlorides, Gattermann-Koch synthesis. Ketones form nitriles, carboxylic acids with alkyl lithium, acid chlorides(with metal alkyls) and esters.

Polarity of carbonyl group and reversal of polarity. Mechanism of aldol condensation. Perkin condensation, Knovenegal condensation, benzoin conder Knovenegal condensation, benzoin condensation, and acetal condensation. General mechanism of condensation with ammonia and its derivatives (NH_2 -R;R=-NH_2 ,-OH, -NH-CO-NH_2). Reduction: Clemmensen and wolf-kishner reductions, reductionby $LiALH_4$ and $NaBH_4$. Mannich reaction

Chapter 10: Carboxylic acids and derivatives 5 hours

Preparation: Acid hydrolysis of nitriles with mechanism. Acidic strength (p^ka values) effect of substituents on the strength of aliphatic and aromatic carboxylic acids (Comparison of acidic strength of formic acid and acetic acid acetic acid and monochloro, dichloro, trichloroacetic acid, benzoic acid and p-nitro benzoic acid, benzoic acid and p-amino benzoic acid).
Reactions: Formation of esters, acid chlorides amides and anhydrides, Hell-Volnardceny reactions. Decarboxylation and reduction (using $LiAlH_4$)
Action of heat on dicarboxylic acids (oxalic acid to adipic acid). Reactions of tartar citric acid (Action of heat, reduction with HI)
Reaction of acid chlorides (hydrolysis, reaction with alcohols and ammonia and lithium dialkylcuprates) acid anhydrides (hydrolysis, reaction with alcohol, ammonia) esters (alkaline hydrolysis, ammonolysis and alcoholysis) Amides (hydrolysis, reduction, Hoffmann rearrangement). Mechanism of ester hydrolysis-acid and base catalysed (acyl O-cleavage: B_{AC}^2 A_{AC}^2: alkyl O- cleavage: A_{AL}^1 mechanisms)

Chapter 11: Tautomerism and enolates 4 hours

Tautomerism in carbonyl compounds. Keto-enol tautomerism. Acidity of a- hydrogen atoms in aldehydes, ketones and active methylene compounds (diethyl malonate, ethylaceto acetate and acetyl acetone). Preparation (from acetic acid and synthetic applications of di ethyl malonate (cinnamic acid, ketones: butanone, Cyclic compound- barbituric acid).

Preparation of ethyl acetoacetate (from ethyl acetate). Synthetic applications (preparation of mono carboxylic acid- butanoic acid) Dicarboxylic acid- succinic acid , unsaturated acids crotonic acid, Ketones- butanone

Semester -V (Organic Chemistry) Paper – V

Unit-I

Chapter 1: Stereochemistry 9 hours

Elements of symmetry (Plane, center and axis with relevant examples), chirality, stereogenic centre (2^{nd} formula for number of steroisomers). Fischer projection formulae.

Enantiomers: Optical activity; use of +/-, d/l and D/L notations. Properties of enantiomers (Glyceraldehyde, Lactic acid), chiral and achiral molecules with two stereogeniccenters (2, 3 dichloro butane, Tartaric acid). Meso compounds. Cohn Ingold-Prelog sequence rules: R & S system of nomenclature.

***Diastereomer*s**: Threo and erythreodiasteromers.

Racemisation and resolution (Chemical & Biochemical). Relative and absolute configuration, Walden inversion.

Optical isomerism dueto restricted rotation about single bonds-diphenyl systems.

Geometric isomerism*:* Determination of configuration of geometric isomers. cis & trans, (i) **Physical methods** (melting and boiling points, dipole moments, solubility) (ii) **Spectroscopic methods** (UV, IR, NMR evidences) (iii) **Chemical methods** (cyclisation method, pKa values and conversion to a compound of known configuration) E, Z system of nomenclature. Geometric isomerism in oximes.

Alicyclic compounds*:* Conformations of four to eight membered cyclo-alkanes and di-substituted cyclo hexanes (1,2-, 1,3- and 1, 4- dimethyl cyclo hexanes) & their relative stabilities.

Bicyclic systems: Nomenclature and conformations of decalins and nor-bornane.

Chapter 2: Amines 5 Hours

Classification, preparation of alkyl and aryl amines reductive amination of carbonyl compounds, Gabriel phthalimide synthesis and Hofmann bromamide reaction.

Basicity of amines*:* Inductive, resonance, steric and solvation effect on the basicity of amines. Reaction of amines as nucleophiles (Reaction with alkyl halides, reductive amination and acylation). Distinguishing reactions of 1°, 2°, and 3° amines. {Acylation, reaction with nitrous acid and Hinsbergs test to distinguish between 1^o, 2^o, 3^o amines (no reactions required for Hinsbergs test)}. Diazotization and synthetic applications of diazonium salts. Sandmeyer's reaction. (conversion to chlorobenzene, bromobenzene and benzonitrile), hydrolysis, reduction (to phenyl hydrazine and aniline), coupling reactions to give azo dyes. (p-hydroxyazobenzene and 1-phenylazo 2-naphthol).

Unit II

Chapter 3: Heterocyclic compounds **5 hours**

Introduction, classification, structures, resonance and aromatic character of furan, pyrrole, thiophene and pyridine. Methods of preparation, furan (from music acid and furfural), thiophene (from acetylene and butane), pyrrole (from acetylene and from ammonium mucate) and pyridine (from acetylene and from nicotinic acid) and reactions of pyrrole, furan, thiophene, pyridine (electrophilic aromatic substitution reactions, nitration and Friedel-crafts reaction), and nucleophilic aromatic substitution of pyridine (Chichibabin reaction) Mechanism of electrophilic substitution reactions. Comparison of basicity of pyrrole, pyridine and piperidine. Preparation of indole by Fischer synthesis, quinoline by Skraup synthesis, isoquinoline by Bischler-Napieralski method and reactions of indole, quinoline and isoquinoline (nitration reaction).

Chapter 4: Chemistry of Natural Products **6 hours**

Carbohydrates: Introduction and classification.

Monosaccharides: Elucidation of open chain structure of D-glucose. Mechanism of mutarotation and anomeric effect. Elucidation of ring structure of D-glucose (by HIO_4 and HNO_3) in detail. Structure of deribose.

Ketoses: Fructose, interconversion of glucose and fructose.

Terpenes and terpenoids: Occurrence, classification (on the basis of number of isoprene units, acyclic and cyclic) and isoprene rule. Elucidation of structure and synthesis of citral. Structures of limonene, menthol, a-terpineol, camphor, ß-carotene, Vitamins - A and their uses.

Alkaloids: Introduction, classification and general characteristics. Structural elucidation and synthesis of nicotine. Structures and uses of ephedrine, caffeine, cocaine, atropine, quinine and morphine.

Unit III

Chapter 5: Spectroscopy of Organic compounds **8 hours**

UV-Visible spectroscopy: Introduction. Chromophores and auxochormes; blue shift and red shift. Graphical representation of spectra of 1,3-butadiene, benzene and lycopene. Influence of conjugation on UV absorption-Comparison of UV spectra of acetone and methyl vinyl ketone.

IR spectroscopy: Introduction. Stretching frequencies of -OH (free, inter and intra H-bonded), alkyl -C-H, C-C, C=C, C=C, C=0 and C-O groups (by taking suitableexamples). Graphical representation of IR spectra of benzoic acid and methyl benzoate.

NMR spectroscopy: Basic principles of proton magnetic resonance: Nuclear magnetic spin quantum number 1, influence of the magnetic field on the spin of nuclei, spin population, saturation using radio frequency. Nuclear magnetic resonance. Chemical shift *(*8 values), advantages of TMS as reference. Nuclear shielding and deshielding effects. Equivalent and non-equivalent protons. Effect of electronegativity *o*f adjacent atoms on chemical shift values. spin-spin splitting and spin-spin coupling (qualitative treatment only).

Applications of NMR spectroscopy including identification of simple organic molecules. Examples: Shielding and deshielding effects for (i) methane (ii) CH_3-CI (iii) CH_2Cl_2 (iv) $CHCI_3$. spin-spin coupling in (i) $C1_2CHCHO$ (ii) 1,1,2-trichloroethane (iii) CH_3CH_2CI.

Chapter 6: Industrial Organic Chemistry 7 hours

Synthetic dyes: Introduction and classification. Colour and constitution. Synthesis of congo red, malachite green, alizarin and indigo.

Drugs:Chemotherapy, classification of drugs (i) drugs used for the treatment of diseases due to infection ii) drugs used for the treatment of diseases not due to infection), Synthesis and uses of paracetamol, diclofenac, ranitidine, sulphanilamide and chloramphenicol.

Retrosynthesis:

Retrosynthesis: Introduction, general terms, synthon, synthetic equivalent, target molecule, general guidelines for disconnection. Retro analysis and synthesis of benzocaine, saccharin

V Semester: Practical 5 *(*Organic Chemistry) 3 hours per week

1. Systematic qualitative analysis of mono functional organic compounds through functional group analysis. Determination of physical constant. Preparation of suitable derivative.

2. Isolation of lycophene from tomatoes.

3. Isolation of caffeine from tea.

Semester – V- (Physical Chemistry)

Unit 1

Chapter 1 : Electrochemistry 16 hours

- Definition of specific conductance(k), equivalent conductance(A) and molar conductance(μ) their units in CGS and SI units. Method of determination of specific conductance. Evaluation of equivalent and molar conductance. Problems only in SI units. Variation of specific and equivalent molar conductance with dilution. Strong and weak electrolytes. Conductometric titrations (only acid-base type, no mixture of acids).
- **Transport numbers:** definition - determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Problems on transport numbers.
- Kohlrausch's law and its applications : (i) evaluation of A_{∞} from A_{+} and A_{-} (ii) evaluation of degree of dissociation of a weak electrolyte (iii) evaluation of A_{∞} of a weak electrolyte (iv) determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and $BaSO_4$). Problems based on these.
- **Limitations of Arrhenius theory**: qualitative account of Debye-Huckel theory, Debye-Huckel-Onsagar equation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation.
- **Galavanic cell**: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nernst equation for single electrode potential (free energy concept).
- **Weston-cadmium cell**: Determination of emf of a cell by compensation method. Determination of E° of Zn/Zn^{2+} and Cu/Cu^{2+} electrodes. Liquid junction potentials, elimination of liquid junction potential.
- **Types of electrodes:** Metal and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. **Reference electrodes**-standard hydrogen electrode and its limitations. Calomel electrode, determination of pH using quinhydrone electrode and glass electrode
- **Concentration cells**: (1) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems.
- **Corrosion Chemistry**: Corrosion - Introduction, Corrosion-an electrochemical phenomenon. Types of corrosion- Galvanic corrosion, Crevice corrosion, Erosion corrosion, Stress corrosion

Unit II

Chapter 2: Ionic equilibria — 4 hours

Hydrolysis of salts of weak acids and weak bases. Jonic product of water. Relationship between K_h K_w, K_a and K_b. Degree of hydrolysis and its relationship with K_h. Effect of temperature and dilution on degree of hydrolysis. pH of salt solutions. Problems.

Common-ion effect, buffers, buffer action and buffer capacity. pH of butlers. Henderson's equation and its derivation. Solubility product and ionic product in precipitation and in qualitative analysis.

Analytical and biological applications of buffers.

Chapter 3: Photochemistry — 5 hours

Laws of photochemistry. Grotthus - Draper law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemical and thermal reactions. Quantum yield of photochemical combination of (i) H_2, and Cl_2(ii) H_2 and Br_2 (iii) dissociation of HI. Photosensitization, photostationary equilibrium. Singlet and triplet states. Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensors.

Beer-Lambert's law and its applications. Numerical problems on absorption coefficient and molar extinction coefficient.

Chapter 4: Solar Energy — 2 hours

Basic properties of solar energy. Applications of solar energy. Transformation of solar energy. Solar heat collectors. Solar photovoltaic collectors. Applications of solar collectors. Examples. Solar power plant.

Unit III

Chapter 5: Chemical Spectroscopy — 13 hours

The interaction of radiation with matter. Regions of electromagnetic spectrum.

Origin of molecular spectra: Born-Oppenheimer approximation.

Rotational spectra of diatomic molecules: Relationship between internuclear distance and moment of inertia. Expression for rotational energy. Numerical problems. Criterion for a molecule to exhibit rotational spectra, absorption of radiation-selection rule.

Vibrational spectra: Hooke's law - Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy, numerical problems. Degree of freedom of polyatomic molecules -- modes of vibration for CO_2 and H_2O molecules.

Raman spectra: Concept of polarisability. Pure rotation, vibration, qualitative study. Stokes and anti-Stoke's lines-selection rules.

Advantages of Raman spectroscopy over IR spectroscopy.

Electronic spectra: Potential energy curves for bonding and antibonding molecular orbitals. Electronic transitions – qualitative description of non-bonding orbitals and transitions between them. Selection rules and Franck-Condon principle.

V Semester practical – 6 (Physical Chemistry) 3 hours per week

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
2. Determination of velocity constant for the saponification of ethyl acetate (a=b).
3. The study of kinetics of potassium persulphate and potassium iodide by colorimetric method.
4. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
5. Determination of dissociation constant of monochloroacetic acid by conductivity method.
6. Conductometric titration of strong acid with a strong base.
7. Conductometric titration of a weak acid with a strong base.
8. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
9. Determination of percentage of sodium chloride by miscibility temperature method.
10. Estimation of Cu^{2+}colorimetrically and verification of Beer-Lambert’s law.

Semester - V (Physical Chemistry)

Unit 1

Chapter 1: Coordination and Organometallic compounds 14 hours

Coordination compounds : Differences between Double salts and complex salts - ligands and their classification, coordination number, nomenclature of coordination compounds, Detection of complex formation, Theories of structure and bonding - Werner's Theory, EAN rule, Valence bond concept, Crystal field theory (octahedral, tetrahedral and square planar complexes) for $[CoF_6]^{3-}$, $[Co(NH_3)_6]^{3+}$, $[Fe(CN)_6]^{4-}$, $[Fe(CN)_6]^{3}$-. Crystal field splitting and crystal field stabilization energies. Magnetic properties of above complexes. Spectral properties of $(Ti(H_2O)_6]^{3+}$. $[Co(H_2O)_6]^{3+}$, $(CoCI_4)^{2-}$, Isomerism-structural and stereoisomerism.

a) **Organometallic compounds** - ligands, classification (hapticity); synthesis and structure of a) $K[PtC1_3(\eta_2\text{-}C_2H_4)]$, $[Fe(\eta_5\text{-}C_5H_5)_2]$,
b) **Metal Carbonyls** - $Cr(CO)_6$, $Co_2(CO)_8$, $Mn_2(CO)_{10}$; eighteen electron rule and its deviations (exceptions to 18 electron rule) as applied to the above complexes.

Applications of coordination/organometallic compounds : cis-platin in cancer therapy, Na_2Ca EDTA in the treatment of heavy metal (Pb, Hg) poisoning, Wilkinson's catalyst in alkene hydrogenation, Monsanto acetic acid process. Zeigler - Natta catalyst in polymerization.

Unit II

Chapter 2 : Industrial Materials 14 hours

Refractories: Properties, classification and examples. PCE values of a refractory and its determination. **Abrasives** – classification, applications, hardness, manufacture, and importance of carborundum, tungsten carbide.

Glass: Properties, types and uses manufacture of soda glass. Borosilicate and optical glasses. Safety glass, fire and bullet proof glasses.

Ceramics: Raw materials, varieties of clay, production of ceramic ware, glazing, insulators.

Cement: Raw materials, grades, manufacture of Portland cement and setting process.

Paints and Varnishes: Constituents of oil, and emulsion paints and their role, constituents of varnishes.

Fuels : Characteristics, Calorific value and its determination using bomb calorimeter, coal-varieties, Gaseous fuels - advantages, constituents and their significance, production of Coal gas and LPG, octane number.

Explosives : Classification, preparation of dynamite and TNT

Propellants: Characteristics, classification and their applications.

Unit III

Chapter 3: Bioinorganic Chemistry **4 hours**

Essential and trace elements in biological systems, metallo-porphyrins with special reference to haemoglobin, myoglobin and chlorophyll. Role of cyanocobalamin in living systems.

Chapter 4: Chemistry of New/Smart materials **8 hours**

Conducting polymers: Definition, types, organic, examples. Conducting polyanilines, polyacetylenes., Qualitative treatment of doping, electroluminescence - Properties, elasticity with high electrical conductivities, Engineering and biological applications

Super conductors : Definition, type 1, 2, Preparation of ceramic super conductor, BCS theory qualitative only and applications of high temperature super conductors.

Fullerenes : Definition, synthesis of C_{60},. Structure and chemical properties of C_{60} and carbon nanotubes, commercial uses : Chemical reactions, redox reactions**,** electrophilic aromatic substitution, brominated C_{60}.

Nanomaterial: Different methods of production. Sol gel synthesis, inert gas condensation, mechanical alloying, plasma synthesis, electrodeposition and applications.

VI Semester : Practical 7 (Inorganic chemistry) **3 hours per week**

1. Estimation of percentage of iron in haematite using diphenyl amine as an internal indicator.
2. Estimation of calcium in limestone by volumetric method.
3. Estimation of copper in brass by volumetric method.
4. Estimation of zinc using EDTA standarised by $ZnSO_4$
5. Estimation of nickel using EDTA and standard zinc sulphatet.
6. Estimation of total hardness of water using EDTA.
7. Gravimetric estimation of barium as barium sulphate.
8. Gravimetric estimation of nickel as nickel dimethyl glyoximate.
9. Preparation of cuprammonium sulphate and determination of λ_{max} and hence CFSE.
10. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
11. Preparation of ferrous oxalate and its analysis (both iron and oxalate).

Semester - VI (Inorganic Chemistry – Paper VII)

Unit I

Chapter 1 :Coordination and Organometallic compounds 14 hours

Coordination compounds : Differences between Double salts and complex sans ligands and their classification, coordination number, nomenclature of coordination compounds, Detection of complex formation, Theories of structure and bonding - Werner's Theory, EAN rule, Valence bond concept, Crystal field theory (octahedral, tetrahedral and square planar complexes) for $(CoF_6]^{3-}$, $[CO(NH_3)_6]^{3+}$, $[Fe(CN)_6]^{4-}$, $[Fe(CN)_6]^{3-}$. Crystal field splitting and crystal field stabilization energies. Magnetic properties of above complexes. Spectral properties of $[Ti(H_2O)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$, $[CoC1_4]^{2-}$, Isomerism-structural and stereoisomerism.

a) **Organometallic compounds** – ligands, classification (hapticity); synthesis andstructure of a) $K[PtCl_3(n_2\text{-}C_2H_4)]$, $[Fe(n_5\text{-}C_5H_5)_2)$,
b) **Metal Carbonyls** – $Cr(CO)_6$, $Co_2(CO)_8$, $Mn_2(CO)_{10}$; eighteen electron rule and its deviations (exceptions to 18 electron rule) as applied to the above complexes.

Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na_2Ca EDTA in the treatment of heavy metal (Pb, Hg) poisoning, Wilkinson's catalyst in alkene hydrogenation, Monsanto acetic acid process. Zeigler - Natta catalyst in polymerization.

Unit II

Chapter 2 : Industrial Materials 14 hours

Refractories : Properties, classification and examples. PCE values of a refractory and its determination.

Abrasives – classification, applications, hardness, manufacture and importance of carborundum, tungsten carbide.

Glass : Properties, types and uses manufacture of soda glass. Borosilicate and optical glasses. Safety glass, fire and bullet proof glasses.

Ceramics : Raw materials, varieties of clay, production of ceramic ware, glazing, insulators.

Cement : Raw materials, grades, manufacture of Portland cement and setting process.

Paints and Varnishes : Constituents of oil, and emulsion paints and their role, constituents of varnishes.

Fuels : Characteristics, Calorific value and its determination using bomb calorimeter, coal-varieties, Gaseous fuels – advantages, constituents and their significance, production of Coal gas and LPG, octanenumber

Explosives : Classification, preparation of dynamite and TNT

Propellants : Characteristics, classification and their applications.

Unit III

Chapter 3 :Bioinorganic Chemistry **4 hours**

Essential and trace elements in biological systems, metallo-porphyrins with special reference to haemoglobin, myoglobin and chlorophyll. Role of cyanocobalamin in living systems.

Chapter 4 :Chemistry of New/Smart materials **4 hours**

Conducting polymers : Definition, types, organic, examples. Conducting polyanilines, polyacetylenes., Qualitative treatment of doping, electroluminescence – Properties, elasticity with high electrical conductivities, Engineering and biological applications.

Super conductors : Definition, type 1, 2, Preparation of ceramic super conductor, BCS theory-qualitative only and applications of high temperature super conductors.

Fullerenes : Definition, synthesis of C_{60}. Structure and chemical properties of C_{60} and carbon nanotubes, commercial uses : Chemical reactions, redox reactions, electrophilic aromatic substitution, brominated C_{60}.

Nanomaterials : Different methods of production. Sol gel synthesis, inert gas condensation, mechanical alloying, plasma synthesis, electrodeposition and applications.

VI Semester : Practical 7 (Inorganic chemistry) **3 hours per week**

1. Estimation of percentage of iron in haematite using diphenyl amine as an internal indicator.
2. Estimation of calcium in limestone by volumetric method.
3. Estimation of copper in brass by volumetric method.
4. Estimation of zinc using EDTA standarised by $ZnSO_4$
5. Estimation of nickel using EDTA and standard zinc sulphatet.
6. Estimation of total hardness of water using EDTA.
7. Gravimetric estimation of barium as barium sulphate.
8. Gravimetric estimation of nickel as nickel dimethyl glyoximate.
9. Preparation of cuprammonium sulphate and determination of λ_{max} and hence CFSE.
10. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
11. Preparation of ferrous oxalate and its analysis (both iron and oxalate).

Semester - VI (Biochemistry – Paper VIII)

Unit 1

Chapter 1: Introduction to Biochemistry **2 hours**

Development of biochemistry as a discipline, elemental and biochemical composition of living organisms. Role of water in biochemical system.

Chapter 2: Carbohydrates **3 hours**

Structure and biological importance of derivatives of monosaccharides – amino sugars, sugar acids, sugar phosphates, N-acetylmuramic acid (NAMA) N acetylneuraminic acid (NANA). Structure and biological importance of oligosaccharides - isomaltose, cellobiose, trehalose. Polysaccharides - source, comparative account of partial structure and biological function of starch, glycogen, cellulose.

Chapter 3 : Lipids **3 hours**

Structure, nomenclature and biological importance of fatty acids - saturated and unsaturated, triglycerides-simple and mixed and phosphoglycerides, sphingolipids - ceramide. Definition and significance of saponification number, iodine number and rancidity. Formation of mono and bilayers of lipids, Clinical significance of lipoproteins and cholesterol.

***C*hapter 4: Proteins** **5 hours**

α- amino acids - classification on the basis of polarity of R - groups. Essential and non-essential amino acids. Peptide bond and its planarity. **Proteins** : Biological importance. Classification based on structure.

Levels of organization of proteins - primary structure, secondary structure (α- helix-triple helix e.g. Collagen and β - pleated), tertiary structure and forces stabilizing it, quaternary structure.

Denaturation and renaturation-Thermal denaturation - Aufinsen's experiment with ribonuclease.

Unit II

Chapter 5: Enzymes **4 hours**

Characteristic features (mention of ribozymes), comparison between biological and non-biological catalyst.

Classification (EC Code number not required), active site, specificity, cofactors, Fischer and Koshland models.

Enzyme Kinetics - factors affecting rate of enzymatic reactions.

Competitive and non- competitive inhibition with examples.

Biochemical techniques: Principle and applications of electrophoresis, chromatography-ion exchange and paper, TLC and column

Chapter 6: Metabolism **8 hours**

Catabolism and anabolism. Carbohydrate metabolism, glycolysis (EMP pathway), fate of pyruvate. TCA cycle, energetics. Gluconeogenesis. Fatty acid metabolism ß - oxidation pathway, energetics Protein metabolism – general aspects of amino acids degradation - deamination, transamination and decarboxylation. Urea cycle.

Chapter 7: Biological oxidation **3 hours**

Introduction, Bioenergetics - ATP and other high energy compounds. Energy coupling in biological reaction. Stepwise process of biological oxidation. Mitochondrial electron transport chain, oxidative phosphorylation. Substrate level phosphorylation.

Unit III

Chapter 8: Nucleic acids **3 hours**

Types : Components of nucleic acids, bases, nucleosides and nucleotides.

Polynucleotides

Structure of DNA (Watson - Crick model) and RNA. Biological roles of DNA and RNA

Chapter 9: Molecular biology **4 hours**

Central dogma of molecular biology – semi conservative replication and mechanism of replication, transcription, translation. DNA Fingerprinting, sequencing - Its applications in Human genome mapping.

Chapter 10: Hormones **3 hours**

Hormones - Definition. Classification into a) Amino acid derivatives b) peptide and polypeptide hormones c) Steroid hormones with important examples and functions.

Role of insulin and glucagons in glucose metabolism.

Mediators of hormone action - Ca^{2+}, cyclic AMP.

Chapter 11: Food Technology **2 hours**

Introduction to food chemistry, Fundamentals of food processing, Fundamentals of milk processing, Food analysis, Food packing technology, Food laws and quality assurance.

.

VI Semester : Practical 8 (Biochemistry) **3 hours per week**

1. Preparation of buffers and determination of their pH values using pH meter.
2. Estimation of reducing sugars by Hegedorn-Jensen method.
3. Estimation of lactose in milk by Nelson-Somyogi's method.
4. Estimation of creatinine by Jaffe's method.

5. Estimation of inorganic phosphate in food samples by Fiske-Subbarow method.
6. Estimation of total reducing sugars in honey by DNS (dinitrosalicylic acid) method.
7. Isolation of lactose and casein from milk and estimation of lactose by colorimetric method demonstration.
8. Estimation of α-amino acids using ninhydrin by colorimetric method.
9. Determination of blood group.
10. Separation of α-amino acids by paper chromatography.
11. Estimation of cholesterol by colorimetric method.

****