
PART III

CHEMISTRY

B.Sc., B.Ed. LIBERAL OPTIONS**PART III: B.SC.B.ED.****Branch: CHEMISTRY**

SEM	No.	CODE	Sub	Name of the course	CCE	UE	Total
I	Core 1		Main 1	Chemistry-I: Atomic Structure, Bonding, General Organic Chemistry	30	70	100
	Core 2		Main 2	Basic Analytical Chemistry	30	70	100
	Core 3		Main 3	Green Chemistry	30	70	100
	Core 4 (Supportive 1)		Anci 1-1	Mathematics-I	30	70	100
II	Core 5		Main 4	Chemistry-II: Chemical Energetics, Equilibria & Functional Organic Chemistry-I	30	70	100
	Core 6		Main 5	Analytical Clinical Biochemistry	30	70	100
	Core 7		Main 6	Chemistry-Laboratory-I Chemistry-I: Atomic Structure, Bonding, General Organic Chemistry		50	50
				Chemistry-Laboratory-II Chemistry-II: Chemical Energetics, Equilibria & Functional Organic Chemistry-I		50	50
	Core 8 (Supportive 2)		Anci 1-2	Mathematics-II	30	70	100
III	Core 9		Main 7	Chemistry-III: Solutions, Phase Equilibrium, Electrochemistry & Functional Group Organic Chemistry-II	30	70	100
	Core 10		Main 8	Fuel Chemistry	30	70	100
	Core 11		Main 9	Molecular Modelling & Drug Design	30	70	100
	Core 12 (Supportive 3)		Anci 2-1	Physics-I	30	70	100
IV	Core 13		Main 10	Chemistry-IV: Coordination Chemistry, States of Matter & Chemical Kinetics	30	70	100
	Core 14		Main 11	Nano Chemistry	30	70	100
	Core 15		Main 12	Chemistry -Laboratory-III Chemistry-III: Solutions, Phase Equilibrium, Electrochemistry & Functional Group Organic Chemistry-II		50	50
				Chemistry-Laboratory-IV Chemistry-IV: Coordination Chemistry, States of Matter & Chemical Kinetics		50	50
	Core 16 (Supportive 4)		Anci 2-2	Physics -II	30	70	100
V	Core 17		Main 13	Analytical Methods in Chemistry	30	70	100
	Core 18		Main 14	Industrial Chemicals & Environment	30	70	100
VI	Core 19		Main 15	Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy	30	70	100
	Core 20		Main 16	Chemistry -Laboratory-V Industrial Chemicals & Environment		50	50
				Chemistry -Laboratory-VI Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy		50	50
VII	Core 21		Main 17	Polymer Chemistry	30	70	100
VIII	Core 22		Main 18	Chemistry -Laboratory-VII Analytical Methods in Chemistry and Analytical Clinical Biochemistry		50	50
				Chemistry -Laboratory-VIII Polymer Chemistry and Molecular Modelling & Drug Design		50	50

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CORE 1: CHEMISTRY-I: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY**Unit-I Atomic Structure**

Atomic Structure: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

Postulates of Quantum Mechanics-Time independent Schrodinger equation (derivation not required) and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for $1s$, $2s$, $2p$, $3s$, $3p$ and $3d$ orbitals (Only graphical representation). Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s . Shapes of s , p and d atomic orbitals, nodal planes. Spin quantum number (s) and magnetic spin quantum number (m_s). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, Anomalous electronic configurations.

(14 Lectures)

Unit- II Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy. Polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding:

VB Approach: Shapes of inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs. MO treatment of homonuclear and heteronuclear diatomic molecules viz., H_2 , O_2 , N_2 , CO , NO and NO^+ . Comparison of VB and MO approaches.

(16 Lectures)

Unit- III Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

(8 Lectures)

Unit- IV Stereochemistry

Conformations: Ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms).

Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds. Threo and erythro; D and L; *cis* – *trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E/ Z Nomenclature (for up to two C=C systems).

(10 Lectures)

Unit V Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations and reactions) to be studied in context to their structure.

Alkanes: *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis and, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: *Preparation:* Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); *cis* alkenes (Partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). *Reactions:* *cis*-addition (alk. KMnO_4) and *trans*-addition (bromine), Addition of HX (Markownikoff's and *anti*-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes: *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* Formation of metal acetylides, addition of bromine and alkaline KMnO_4 , ozonolysis and oxidation with hot alk. KMnO_4 .

(12 Lectures)

Reference Books:

1. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
5. Graham Solomons, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
6. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
7. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
8. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
9. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
11. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010

CORE 2: BASIC ANALYTICAL CHEMISTRY

Unit I - Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: a. Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators
a. Determination of pH of soil samples.
b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Unit II - Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.
a. Determination of pH, acidity and alkalinity of a water sample.
b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.
a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

Unit III - Chromatography:

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

- Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).
- To compare paint samples by TLC method.

Ion-exchange: Column, ion-exchange chromatography etc.

Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Unit IV - Analysis of cosmetics:

Major and minor constituents and their function

- Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
- Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Suggested Applications (Any one):

- To study the use of phenolphthalein in traps cases.
- To analyze arson accelerants.
- To carry out analysis of gasoline.

Unit V - Suggested Instrumental demonstrations:

- Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
- Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
- Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Reference Books:

1. Willard, H.H., Merritt, L.L., Dean, J. & Steptoe, F.A. *Instrumental Methods of Analysis*. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. *Physical Biochemistry 2nd Ed.*, W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
10. Vogel, A. I. *Vogel's Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).

CORE 3: GREEN CHEMISTRY**Unit I****Introduction and Principles - Part A**

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

(4 Lectures)

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.

Unit II Principles - Part B

Prevention/ minimization of hazardous/ toxic products reducing toxicity. risk = (function) hazard \times exposure; waste or pollution prevention hierarchy.

Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents.

Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.

Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.

Unit III Principles - Part C

Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD “What you don’t have cannot harm you”, greener alternative to Bhopal Gas Tragedy (safer route to carbaryl) and Flixborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation. Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

(30 Lectures)

Unit IV Examples of Green Synthesis/ Reactions and some real world cases

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents
3. Diels-Alder reaction and Decarboxylation reaction
4. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)
5. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO₂ for precision cleaning and dry cleaning of garments.
6. Designing of Environmentally safe marine antifoulant.
7. Rightfit pigment: synthetic azo pigments to replace toxic organic and inorganic pigments.

8. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.
 9. Healthier fats and oil by Green Chemistry: Enzymatic inter esterification for production of no Trans-Fats and Oils
 10. Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting
- (16 Lectures)

Unit – V Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial greenchemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

(10 Lectures)

Reference Books:

1. Ahluwalia, V.K. & Kidwai, M.R. *New Trends in Green Chemistry*, Anamaya Publishers (2005).
2. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
3. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
4. Cann, M.C. & Connelly, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
5. Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
6. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.

List of Experiments for Practical

1. Safer starting materials

Preparation and characterization of nanoparticles of gold using tea leaves.

2. Using renewable resources

Preparation of biodiesel from vegetable/ waste cooking oil.

3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

(I) Triethylamine ion + OH⁻ → propene + trimethylpropane + water

(II) 1-propanol + H₂SO₄/Δ → propene + water

Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

5. Alternative Green solvents

Extraction of D-limonene from orange peel using liquid CO₂ prepared from dry ice. Mechanochemical solvent free synthesis of azomethines.

6. Alternative sources of energy

1. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
2. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhuri, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore ISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society (2008).
7. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.
8. Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to Organic Laboratory Techniques: A Microscale and Macroscale Approach*, W.B.Saunders, 1995.

CORE 4: (SUPPORTIVE 1)- MATHEMATICS-I**UNIT-1 (ALGEBRA)**

Matrices - Rank of a matrices - Consistency of a system of linear non-homogeneous equations (statement only) - Simple problems - Characteristic roots of a square matrix - Evaluation of Eigen values and Eigen vectors of a square matrix - Cayley Hamilton theorem (statement only) - Simple problems.

UNIT -2 (TRIGNOMETRY)

De Moivre's theorem - Expansions of $\cos(n\theta)$, $\sin(n\theta)$ and $\tan(n\theta)$ - Powers of sines and cosines of θ in terms of functions of multiples of θ . Expansions of $\sin(\theta)$, $\cos(\theta)$ in a series of ascending powers of θ - Limits and approximations.

UNIT-3 (FUNCTIONS OF COMPLEX VARIABLE)

Analytic functions - Cauchy Riemann equations - derivation and simple problems - Harmonic functions

UNIT-4 (VECTOR CALCULUS)

Vector differentiations - Scalar point functions - Vector point functions - Derivatives of a Vector point functions, sum of two vector point functions, product of scalar and Vector point function, Vector product - The vector operator Del, Gradient, Divergence and Curl - Simple application problems involving Cartesians - Laplace Operator.

UNIT - 5 (POLAR CO-ORDINATES)

Angle between radius and vector and tangent - Angle of intersection of two curves - Pedal equations of a curve

Text books:

1. S. Narayanan and T.K. Manicavachagom pillai, Calculus, S. Viswanathan Publishers
2. S. Narayan, Trignometry, S. Viswanathan Publishers, 2012
3. P. DuraiPandian, Complex Variable, Emerald Publishers, 1979
4. P. DuraiPandian, Vector Calculus, 1984
5. Vittal and Malini, Allied Mathematics, V.Margham Publishers, 1997

Reference Books:

1. George B.Thomas, Maurice D.Weir and Joel Hass, Thomas' Calculus 12'h Edition, Pearson Education, 2015
2. Er.vin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9th Edition, 2011
3. Gilbert Strang, Linear Algebra and Its Applications, CENGAGE Learning, 2007.

CORE 5: CHEMISTRY-II; CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

Unit I - Chemical Energetics and Chemical Equilibria

Laws of Thermodynamics. Important principles and definitions of thermochemistry. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchoff's equation. Statement of Third Law of thermodynamics.

(10

Lectures) Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG° , Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases.

(8 Lectures)

Unit II -Ionic Equilibria

Types of electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

(12 Lectures)

Unit III – Aromatic Hydrocarbons

Functional group approach for the following reactions (preparations and reactions) to be studied in context to their structure.

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulfonation. Friedel-Craft's reaction (alkylation and acylation). Side chain oxidation of alkyl benzenes.

(8 Lectures)

Unit IV - Alkyl and Aryl Halides

Alkyl Halides: Types of Nucleophilic Substitution (S_N1 , S_N2 and S_Ni) reactions.

Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite and nitro formation, nitrile and isonitrile formation.

Williamson's ether synthesis: Elimination versus substitution.

Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (*Chlorobenzene*): Aromatic nucleophilic substitution (replacement by $-OH$ group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

(8 Lectures)

Unit V - Aliphatic and Aromatic Carbonyl Compounds, Alcohols, Phenols and Ethers

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) *Preparation:* from acid chlorides and from nitriles.

Reactions: Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro reaction, Wittig reaction, Benzoin condensation. Clemmensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf-Verley reduction.

Alcohols, Phenols and Ethers (Up To 5 Carbons)

Alcohols: *Preparation:* Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (alk. KMnO₄, acidic dichromate, conc. HNO₃). Oppenauer oxidation *Diols:* (Up To 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts.

Reactions: Electrophilic substitution: Nitration, halogenation and sulfonation. Reimer Tiemann Reaction, Gattermann-Koch Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

(14 Lectures)

Reference Books:

1. Graham Solomons, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
4. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S
5. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
6. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
7. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
8. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
9. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
10. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
11. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

CORE 6: ANALYTICAL CLINICAL BIOCHEMISTRY**Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:****Unit I: Review of concepts studied in the core course:**

Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysaccharides.

Unit II - Proteins:

Classification, biological importance; Primary and secondary and tertiary structures of proteins: α -helix and β -pleated sheets, Isolation, characterization, denaturation of proteins.

Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Unit III - Lipids:

Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Lipoproteins.

Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.

Unit IV – DNA & RNA

Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy. *Enzymes:* Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

Unit V - Biochemistry of disease: A diagnostic approach by blood/ urine analysis.

Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

Urine: Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

List of Experiments for Practical

Identification and estimation of the following:

1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Reference Books:

1. T.G. Cooper: Tool of Biochemistry.
2. Keith Wilson and John Walker: Practical Biochemistry.
3. Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
4. Thomas M. Devlin: Textbook of Biochemistry.

5. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
6. Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed. PHI Learning.
7. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.*, W. H. Freeman.
8. Mikes, O. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Horwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

CORE 7: CHEMISTRY-LABORATORY**CHEMISTRY LABORATORY-I: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY****List of Experiments for Practical*****Volumetric Analysis***

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO_4 .
3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .
4. Estimation of Fe (II) ions by titrating it with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $\text{Na}_2\text{S}_2\text{O}_3$.
6. Estimation of hydrogen peroxide.

Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing up to two extra elements).
2. Separation of organic compounds based on solubility.
3. Separation of mixtures by Chromatography: Measurement of the R_f value in each case (combination of two compounds to be given)
 - a) Identification and separation of the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.
 - b) Identification and separation of the sugars present in the given mixture by paper chromatography.

Reference Books:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
 2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
 3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Orient-Longman, 1960

CHEMISTRY LABORATORY-II: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I**List of Experiments for Practical*****Physical Chemistry*****(Thermochemistry)**

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO₃, NH₄Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH .

Ionic Equilibria (pH measurements)

1. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
2. Preparation of buffer solutions:
 - a. Sodium acetate-acetic acid
 - b. Ammonium chloride-ammonium hydroxide
3. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yield to be done.
 - a) Bromination of Phenol/Aniline
 - b) Benzoylation of amines/phenols
 - c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone
- 4 (a) Estimation of Aniline
(b) Estimation of Phenol.

Reference Books

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R.Chand & Co.: New Delhi (2011).

CORE 8: (SUPPORTIVE 2) MATHEMATICS-II**UNIT -1 (INTEGRAL CALCULUS)**

Evaluation of $\int e^{ax} \cos(bx) dx$ and $\int e^{ax} \sin(bx) dx$, - Bernoulli's formula for integration by parts – Definite integrals – reduction formulae – Related definite integrals – properties – reduction formula for $\int e^{ax} x^n dx$, $\int \sin^n x dx$ and $\int \cos^n x dx$ (n is a positive integer) - Evaluation

of $\int_0^{\infty} e^{-x} x^n dx$, $\int_0^{\pi/2} \sin^n x dx$, $\int_0^{\pi/2} \cos^n x dx$, - Rule of writing down

$\int_0^{\pi/2} \sin^m x \cos^n x dx$ and illustrations

UNIT -2 (VECTOR INTEGRATION)

Gauss Divergence theorem and Stokes's theorem (Statement only) – Simple problems

UNIT-3 (FOURIER SERIES)

Definition – Finding Fourier co-efficient for a given period function with period 2π -

Odd and Even functions – Half range series

UNIT-4 (ORDINAR DIFFERENTIAL EQUATIONS)

Equations of the first order but not of the first degree – Equations solvable for dy/dx , - equations solvable for y - Equations Solvable for x - Clairaut's form (simple cases) – Linear equations with constant coefficients – Evaluation of the particular integral of the equation – e^x , $\sin(ax)$, $\cos(ax)$, x^k , $e^{ax}f(x)$

UNIT – 5 (LAPLACE TRANSFORM)

Definitions – Condition for the existence of Laplace transform – Laplace transform of 1, e^{at} , e^{-at} , $\cos(at)$, $\sin(at)$, $\sinh(at)$, $\cosh(at)$ and t^n - Simple problems – Laplace transform of the derivatives – Laplace transform of the integral – first shifting theorem – change of scale of property – Laplace transform of function multiplied by t , divisible by t – inverse Laplace transform – solution of ordinary differential equations using Laplace transforms

Text books:

1. S. Narayanan and T.K. Manicavachagom pillai, Calculus, S. Viswanathan Publishers
2. P. DuraiPandian, Vector Calculus, 1984
3. Vittal and Malini, Allied Mathematics, V.Margham Publishers, 1997

Reference Books:

1. George B.Thomas, Maurice D.Weir and Joel Hass, Thomas' Calculus 12th Edition, Pearson Education, 2015
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9th Edition, 2011

**CORE 9: CHEMISTRY-III: SOLUTIONS, PHASE EQUILIBRIUM,
ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II****Unit I Solutions and Phase****Equilibria Solutions**

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

(8 Lectures)

Phase Equilibrium

Phases, components and degrees of freedom of a system. Gibbs Phase Rule. Derivation of Clausius–Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water) and two component systems involving eutectics (lead-silver, metal-organic compound system).

(8 Lectures)

Unit II**Electrochemistry****Conductance**

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.

Transference number. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

(6 Lectures)

Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Standard Hydrogen Electrode (SHE). Standard electrode potential. Electrochemical series.

Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

pH determination using hydrogen electrode.

Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

(8 Lectures)

Unit III Carboxylic acids, Amines and Diazonium Salts

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Carboxylic acids (aliphatic and aromatic): *Preparation* (Acidic and Alkaline hydrolysis of esters) and *Reaction*: (Hell – Volhard - Zelinsky Reaction).

Carboxylic acid derivatives (aliphatic): *Preparation* (Acid chlorides, Anhydrides, Esters and Amides from acids) and their interconversion.

Reactions: Reformatsky Reaction, Perkin condensation.

(6 Lectures)

Amines (Aliphatic and Aromatic):

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Hofmann versus Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO₂, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: *Preparation*: from aromatic amines.

Reactions: conversion to benzene, phenol, dyes.

(6 Lectures)

Unit IV Amino Acids, Peptides and Proteins:

Preparation of Amino Acids: Strecker synthesis, using Gabriel's phthalimide synthesis.

Zwitterion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: esterification of $-\text{COOH}$ group, acetylation of $-\text{NH}_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

Determination of Primary structure of Peptides by degradation - Edman degradation (N-terminal) and C-terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by *N*-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

(10 Lectures)

Unit V Carbohydrates:

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

(8 Lectures)

Reference Books:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
6. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry (Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry* 7th Ed., W. H. Freeman.
10. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

CORE 10: FUEL CHEMISTRY**Unit I - Review of energy sources** (renewable and nonrenewable).

Classification of fuels and their calorific value.

Unit II - Coal:

Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Unit III - Petroleum and Petrochemical Industry:

Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, biogas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Unit IV - Petrochemicals:

Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Unit V- Lubricants:

Classification of lubricants, lubricating oils (conducting and nonconducting) Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Reference Books:

1. Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
2. Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.
3. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).

CORE 11: MOLECULAR MODELLING & DRUG DESIGN**Unit I Introduction to Molecular Modeling**

Introduction: Useful Concepts in Molecular Modeling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

(10 Lectures)

Unit II Force Fields

Fields. Bond Stretching. Angle Bending. Introduction to non-bonded interactions. Electrostatic interactions. van der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

(14 Lectures)

Unit III Energy Minimization and Computer Simulation

Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.

(12 Lectures)

Unit IV Molecular Dynamics & Monte Carlo Simulation

Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.

(12 Lectures)

Unit V Structure Prediction and Drug Design

Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design, Drug Discovery – Chemoinformatics – QSAR.

(12 Lectures)

Reference Books:

1. Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
2. Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
3. Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

CORE 12: (SUPPORTIVE 3) PHYSICS-I

UNIT-I: Moment of inertia – radius of gyration - parallel and perpendicular axis theorem, calculation of moment of inertia of (a) ring (b) disc (c) hollow and solid spheres. Angular momentum, torque and the relation between them. Simple harmonic motion, equation of SHM, composition of two SHM at right angles, Lissajous figures.

UNIT-II: Young's modulus — bulk modulus — rigidity modulus and Poisson's ratio — derivation of the expression for bending moment of a beam in terms of its curvature of neutral axis – determination of Young's modulus of a rectangular bar — non – uniform bending — pin and microscope method-with theory (mathematical derivation) – expression for couple per unit twist-determination of rigidity modulus – torsion pendulum.

UNIT-III: Surface tension and surface energy – interfacial surface tension-experimental determination of surface tension by drop weight method-variation of surface tension with temperature — Jaeger's method – streamline and turbulent motion- equation of continuity.

UNIT -IV: Newton's law of cooling – determination of specific heat of liquid-Barton's cooling correction in calorimetric experiments – specific heat capacity of gases – ratio of specific heat capacities — determination of the ratio of specific heats of gases – Clement and Desormes method. Coefficient of thermal conductivity of a bad conductor - Lee's disc method-determination of thermal conductivity by Forbes's method. Blackbody radiation-Stefan's law – determination of Stefan's constant — second law of thermodynamics –Carnot cycle – indicator diagram – derivation of efficiency-Kelvin temperature scale.

UNIT - V: Interference — method of producing coherent sources - Fresnel's biprism — Newton's rings through transmission and reflection - Interferometers - Michelson's Interferometer – wavelength determination - Jamin's refractometer. Diffraction - Fresnel's diffraction – Fraunhofer diffraction – half period zones-rectilinear propagation of light – diffraction at a straight edge. Polarization – optical activity-specific rotator power – Polarimeter – Lawrence half shade - determination of specific rotator power-double refraction – optic axis.

TEXTBOOKS:

1. Dr.Sabesan and others, A Textbook of Allied Physics Vol-I and Vol-II
2. Ponnusamy and others, Ancillary Physics.
3. Kamalakannan and others, Ancillary Physics.

REFERENCE BOOKS

1. Halliday, Resnik & Walker, Fundamentals of Physics, 5 Ed.(Asian Books Pvt. Ltd., New Delhi)

PHYSICS I – PRACTICALS

Choose any 7 experiments from the list given below for each semester without overlap

LIST OF EXPERIMENTS:

1. Young's modulus-Non-Uniform bending-Pin & Microscope
2. Rigidity modulus-Torsional oscillations without masses.
3. Comparison of coefficient of viscosity.
4. Surface tension of a liquid and interfacial surface tension by drop weight method.
5. Spectrometer – Refractive index of a liquid- Hollow prism.
6. Spectrometer -Grating-N determination by normal incidence method.
7. Spectrometer -Grating-wavelength determination by minimum deviation method.
8. Newton's Rings.
9. Thermal conductivity of a bad conductor - Lee's disc method
10. Post office box- laws of resistance and specific resistance.
11. Melde's apparatus-Determination of frequency.
12. Meter Bridge - Temperature coefficient of the material of a coil of wire
13. Potentiometer – calibration of low range voltmeter (0 -1.5 V).
14. Potentiometer - calibration of ammeter (0-1.5 amps).
15. Figure of merit of a periodic moving coil galvanometer.
16. Field along the axis of the circular coil carrying current- Determination of BH.
17. Newton's law of cooling and specific heat determination
18. Frequency measurement by forming Lissajous figures
19. Study of Half wave rectifier.
20. Transistor characteristics-CE mode- only transfer characteristics.

TEXTBOOKS:

1. Ouseph and V.Srinivasan, Practical Physics- Part-I &II.

REFERENCE BOOKS

1. Mathchan Lazarus and others-Practical Physics

CORE 13: CHEMISTRY-IV: COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS**Unit-I Transition Elements (3d series)**

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, and Cr.

Lanthanoids and actinoids: Electronic configuration, oxidation states, colour, magnetic properties, lanthanide contraction and its consequences, separation of lanthanides (ion exchange method only).

(12 Lectures)

Unit-II Coordination Chemistry

IUPAC system of nomenclature. **Valence Bond Theory (VBT):** Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT.

(8

Lectures) **Crystal Field Theory:** Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for *Oh* and *Td* complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion.

(10 Lectures)

Unit-III Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. vander Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

(8 Lectures)

Unit IV – Condensed States of**Matter Liquids**

Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on coefficient of viscosity of a liquid (qualitative treatment only).

(6 Lectures)

Solids

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X-Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals (Schottky and Frenkel only). Glasses and liquid crystals.

(8 Lectures)

Unit-V Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Half-life of a reaction. General methods

for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

(8 Lectures)

Reference Books:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry*, Wiley.
7. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
8. Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
9. Rogers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.

CORE 14: NANO CHEMISTRY**Unit-I: Basics of Nanochemistry**

Basics of nanomaterials: Properties of nanomaterials, quantum confinement effect, surface to volume ratio, surface properties of nanoparticles. Classification of the nano materials – zero dimensional, one dimensional, two dimensional and three dimensional nanostructures.

Unit-II: Properties of Nanomaterials

Mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. Size dependent properties-size dependent absorption spectra

Unit-III: Synthetic Techniques

Chemical methods: sol-gel synthesis, solvothermal synthesis, thermolysis route. Physical methods: Pulsed laser deposition- Magnetron sputtering

Unit-IV: Applications of Nanomaterials

Catalysis on nanoparticles, semiconductors, sensors, and electronic devices, photochemistry and nanophotonics, applications of CNTs, nanomaterials in biology and medicine.

Unit-V: Characterization Techniques

X-ray diffraction- Electron microscopes – scanning electron microscopes (SEM) – transmission electron microscopes (TEM) – scanning probe microscopy – atomic force microscopy (AFM) – scanning tunneling electron microscope (STEM) – basic principles only.

Reference Books:

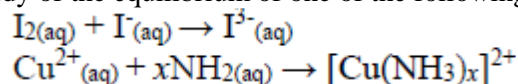
1. S.Shanmugam, Nanotechnology, , MJP Publishers, Chennai (2010).
2. Patrick Salomon , A Handbook on Nanochemistry,, Dominant Publishers and Distributers, New Delhi.
3. S. Balaji , Nanobiotechnology, MJP Publishers, Chennai (2010).
4. CNR Rao The Chemistry of Nanomaterial: Synthesis, Properties and Applications, Vol. I and II, Springer (2006).
5. Nanotechnology: Basic Science and Emerging Technologies, Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press, (2005).
6. G. B. Segreev, Nanochemistry, , Elsevier, Science, New York, (2006).
7. C. N. R. Rao, A. Mu'ller, A. K. Cheetham, "The Chemistry of Nanomaterials: Synthesis, Properties and Applications" WILEY-VCH Verlag GmbH & Co. KGaA, weinheim, 2004
8. C.N.R. Rao, G.U. Kulkarni, P.J. Thomas, Nanocrystals: Synthesis, Properties and Applications" Springer Series in materials science-95, Springer-Verlag Berlin Heidelberg 2007
9. Znong Lin Wang, "Characterization of nanophase materials" WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2000.

List of Experiments for Practical

1. Chemical synthesis of Ag nanoparticles; UV-Visible absorption of the colloidal sol; Mie formalism; Estimation of size by curve fitting
2. Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap estimation from the band edge
3. Synthesis of ZnS nanoparticles by chemical route and determination of band structure through UV-Vis spectroscopy.
4. Aqueous to organic phase transfer of Ag and CdS nanoparticles; Confirmation by UV- Visible absorption.

CORE 15: CHEMISTRY LABORATORY**CHEMISTRY LABORATORY III: SOLUTIONS, PHASE EQUILIBRIUM,
ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II****List of Experiments for****Practical Physical Chemistry****Distribution**

Study of the equilibrium of one of the following reactions by the distribution method:

**Phase Equilibria**

- Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
- Determination of the critical solution temperature and composition of the phenol-water system and study of the effect of impurities on it.
- Study of the variation of mutual solubility temperature with concentration for the phenol-water system and determination of the critical solubility temperature.

Conductance

- Determination of cell constant
- Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
- Performing the following conductometric titrations:
 - Strong acid vs. strong base
 - Weak acid vs. strong base

Potentiometry

Performing the following potentiometric titrations:

- Strong acid vs. strong base
- Weak acid vs. strong base
- Potassium dichromate vs. Mohr's salt

Organic Chemistry

- Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.
- Separation of amino acids by paper chromatography.
 - Determination of the concentration of glycine solution by formylation method.
 - Titration curve of glycine.
 - Action of salivary amylase on starch
 - Effect of temperature on the action of salivary amylase on starch.
 - Differentiation between a reducing and a nonreducing sugar.

Reference Books:

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry*, Universities Press

CHEMISTRY LABORATORY IV: COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

List of Experiments for Practical

Inorganic Chemistry

Semi-micro qualitative analysis using H₂S of mixtures - not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : NH₄⁺, Pb²⁺, Cu²⁺, Cd²⁺, Fe³⁺, Al³⁺, Co²⁺, Cr³⁺, Ni²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺
Anions: CO₃²⁻, S²⁻, SO₄²⁻, NO₂⁻, CH₃COO⁻, Cl⁻, Br⁻, I⁻, NO₃⁻, SO₃²⁻, PO₄³⁻, BO₃³⁻, C₂O₄²⁻, F⁻

(Spot tests should be carried out wherever feasible)

1. Estimation of the amount of nickel present in a given solution as bis(dimethylglyoximate)nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Drawing calibration curve (absorbance at λ_{max} vs. concentration) for various concentrations of a given coloured compound (KMnO₄/ CuSO₄) and estimation of the concentration of the same in a given solution.
3. Determination of the composition of the Fe³⁺-salicylic acid complex solution by Job's method.
4. Estimation of (i) Mg²⁺ or (ii) Zn²⁺ by complexometric titrations using EDTA.
5. Estimation of total hardness of a given sample of water by complexometric titration.
6. Determination of concentration of Na⁺ and K⁺ using Flame Photometry.

Physical Chemistry

- I. Viscosity measurement (use of organic solvents excluded).
 - i. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
 - ii. Studying of the variation of viscosity of an aqueous solution with concentration of solute.
- II. Chemical Kinetics

Studying the kinetics of the following reactions.

 - a. Initial rate method: Iodide-persulphate reaction

Integrated rate method:

 - b. Acid hydrolysis of Ethyl acetate with hydrochloric acid.
 - c. Saponification of ethyl acetate.
 - d. Comparison of the strengths of Acids by studying kinetics of hydrolysis of ethyl acetate

Reference Books:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

CORE 16: (SUPPORTIVE 4)- PHYSICS -II

UNIT-I: Ultrasonics – magneto-striction – piezo electric methods – properties of ultrasonic waves and applications.

UNIT -II:Gauss's law with proof – Electric intensity and potential due to a uniformly charged hollow conductor at a point outside, on the surface and inside a spherical conductor — capacity of a parallel plate condenser with and without a dielectric slab - capacity of a spherical conductor-Biot & Savart's law — field along the axis of a circular coil carrying current – force on current carrying conductor placed in a magnetic field – theory of moving coil galvanometer.

UNIT -III: Magnetic properties of materials – relation between – the three magnetic vectors – susceptibility and permeability - para, dia and ferromagnetism (qualitative ideas) – magnetic hysteresis – superconductivity – persistent current and Meissner Effect.

UNIT-IV: Breakdown of classical mechanics — photo electric effect — Compton effect - Davison- Germer experiment - Matter waves-wave pockets -de Broglie ideas- Heisenberg uncertainty principle. Radio active isotopes (production and uses) – particle accelerator – linear accelerator – particle detectors – Wilson cloud chamber – Scintillation counter – nuclear models – Liquid drop model-Fission and Fusion reaction- nuclear reactors.

UNIT-V: Rectifiers & filters (qualitative ideas) – Transistor characteristics – transistor as a RC coupled amplifier – frequency response (without derivation) – band width – basic principles of an oscillator-Hartley oscillator – working (without derivation) – elementary ideas about modulation – elementary ideas about TV transmission and reception.

TEXTBOOKS:

1. Dr.Sabesan and others, A Textbook of Allied Physics-Vol-I and Vol-II.
2. Ponnusamy and others, Ancillary Physics.
3. Kamaiakannan and others, AncillaryPhysics.

REFERENCEBOOKS

1. Halliday, Resnik, Walker, Fundamentals of Physics, 5thEd. (Asian Books Pvt. Ltd., New Delhi)

PHYSICS II – PRACTICALS

Ref: Physics Practical I

CORE 17: ANALYTICAL METHODS IN CHEMISTRY**Unit I Qualitative and quantitative aspects of analysis:**

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

(5 Lectures)

Unit II Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data.

Unit III Flame Atomic Absorption and Emission Spectrometry

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction. Techniques for the quantitative estimation of trace level of metal ions from water samples

Unit IV Thermal and Electroanalytical methods of analysis

Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

(5 Lectures)

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

(10 Lectures)

Unit V Separation techniques

Solvent extraction: Classification, principle and efficiency of the technique. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.

Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC. Chiral chromatographic techniques using chiral columns (GC and HPLC).

(15 Lectures)

Reference Books:

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3. Christian, G.D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D. C. *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.

6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
7. Mikes, O. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Horwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.

CORE 18: INDUSTRIAL CHEMICALS & ENVIRONMENT**Unit I Industrial Gases and Inorganic Chemicals**

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

(10 Lectures)

Unit II Industrial Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.

Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process.

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

(8 Lectures)

Unit III Environment and its Segments Part A

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO₂, CO₂, CO, NO_x, H₂S and other foul smelling gases. Methods of estimation of CO, NO_x, SO_x and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Unit IV Environment and its Segments

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment).

Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for wastewater, industrial water and domestic water.

(30 Lectures)

UNIT V Energy & Environment

Sources of energy: Coal, petroleum and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydro, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

(10 Lectures)

Biocatalysis

Introduction to biocatalysis: Importance in “Green Chemistry” and Chemical Industry.

(6 Lectures)

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
8. G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
9. A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005)

**CORE 19: ORGANOMETALLICS, BIOINORGANIC CHEMISTRY,
POLYNUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY****Unit I: Chemistry of 3d metals**

Oxidation states displayed by Cr, Fe, Co, Ni and Co.

A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

(6 Lectures)

Unit II: Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).

(6 Lectures)

Unit III: Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+ , K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

(12

Lectures) **Unit IV: Polynuclear and heteronuclear aromatic compounds and Active methylene compounds:**

Polynuclear and heteronuclear aromatic compounds:

Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole, Thiophene, and Pyridine.

(6 Lectures)

Active methylene compounds:

Preparation: Claisen ester condensation. Keto-enol tautomerism.

Reactions: Synthetic uses of ethylacetoacetate (preparation of non-heteromolecules having upto 6 carbon).

(6 Lectures)

Unit V: Application of Spectroscopy to Simple Organic Molecules

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules.

Electromagnetic radiations, electronic transitions, λ_{max} & ϵ_{max} , chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{max} of conjugated dienes and α, β - unsaturated compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region.

IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on $>C=O$ stretching absorptions).

(18 Lectures)

Reference Books:

1. James E. Huheey, Ellen Keiter & Richard Keiter: *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
2. G.L. Miessler & Donald A. Tarr: *Inorganic Chemistry*, Pearson Publication.
3. J.D. Lee: *A New Concise Inorganic Chemistry*, E.L.B.S.
4. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley & Sons.
5. I.L. Finar: *Organic Chemistry* (Vol. I & II), E.L.B.S.
6. John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds*, Prentice Hall.
7. R.M. Silverstein, G.C. Bassler & T.C. Morrill: *Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.
8. R.T. Morrison & R.N. Boyd: *Organic Chemistry*, Prentice Hall.
9. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
10. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand.

CORE 20: CHEMISTRY LABORATORY**CHEMISTRY LABORATORY-V: INDUSTRIAL CHEMICALS & ENVIRONMENT****List of Experiments for Practical**

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO_3 and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-} , HCO_3^-) using double titration method.
7. Measurement of dissolved CO_2 .
8. Study of some of the common bioindicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt. Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi

CHEMISTRY LABORATORY-VI: ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLYNUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY**List of Experiments for Practical****Inorganic Chemistry**

1. Separation of mixtures by chromatography: Measure the R_f value in each case. (Combination of two ions to be given)
Paper chromatographic separation of Fe^{3+} , Al^{3+} and Cr^{3+} or
Paper chromatographic separation of Ni^{2+} , Co^{2+} , Mn^{2+} and Zn^{2+}
2. Preparation of any two of the following complexes and measurement of their conductivity:
 - (i) tetraamminecarbonatocobalt (III) nitrate
 - (ii) tetraamminecopper (II) sulphate
 - (iii) potassium trioxalatoferrate (III) trihydrateCompare the conductance of the complexes with that of M/1000 solution of NaCl, MgCl_2 and LiCl_3 .

Organic Chemistry

Systematic Qualitative Organic Analysis of Organic Compounds possessing mono functional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

Reference Books:

1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

CORE 21: POLYMER CHEMISTRY**Unit I Introduction and importance of polymeric materials**

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers.

(4 Lectures)

Functionality and its importance:

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

(8 Lectures)

Unit II Kinetics of Polymerization

Mechanism and kinetics of step growth, radical chain growth and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

(8 lectures)

Unit III Structure and Morphology of Polymers

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

(4 Lectures)

Glass transition temperature (T_g): Determination of T_g Factors affecting glass transition temperature (T_g).

(8 Lectures)

Nature and structure of polymers-Structure Property relationships.

Polymer Solutions – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Lower and Upper critical solution temperatures.

(8 Lectures)

Determination of molecular weight of polymers (*M_n*, *M_w*, etc) light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

(8 Lectures)

Unit V P Preparation and Properties of Polymers

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride), poly(vinyl acetate), acrylic polymers, fluoropolymers, polyamides. Phenol formaldehyde resins (Bakelite, Novolac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

(10 Lectures)

Reference Books:

1. Seymour, R.B. & Carraher, C.E. *Polymer Chemistry: An Introduction*, Marcel Dekker, Inc. New York, 1981.
2. Odian, G. *Principles of Polymerization*, 4th Ed. Wiley, 2004.
3. Billmeyer, F.W. *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
4. Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
5. Lenz, R.W. *Organic Chemistry of Synthetic High Polymers*. Interscience Publishers, New York, 1967.

CORE 22: CHEMISTRY -LABORATORY**CHEMISTRY LABORATORY-VII: ANALYTICAL METHODS IN CHEMISTRY
AND ANALYTICAL CLINICAL BIOCHEMISTRY****List of Experiments for Practical: Analytical Methods in Chemistry****I. Separation Techniques Chromatography:**

(a) Separation of mixtures

(i) Paper chromatographic separation of Fe^{3+} , Al^{3+} , and Cr^{3+} .

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by

TLC

II. Solvent Extractions:

1. Separation of a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} DMG complex in chloroform, and determine its concentration by spectrophotometry.

2. Solvent extraction of zirconium with amberlite LA-1, separation from a mixture of iron and gallium.

3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

4. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.

5. Analysis of soil:

a. Determination of pH of soil.

b. Total soluble salt

c. Estimation of calcium, magnesium, phosphate, nitrate

6. Ion exchange:

a. Determination of exchange capacity of cation exchange resins and anion exchange resins.

b. Separation of metal ions from their binary mixture.

c. Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pK_a values of indicator using spectrophotometry.

2. Structural characterization of compounds by infrared spectroscopy.

3. Determination of dissolved oxygen in water.

4. Determination of chemical oxygen demand (COD).

5. Determination of Biological oxygen demand (BOD).

6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Reference Books:

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.

2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

3. Christian, Gary D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New

- York, 2004.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
 - Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
 - Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
 - Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
 - Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.

List of Experiments for Practical: Analytical Clinical Biochemistry

Identification and estimation of the following:

- Carbohydrates – qualitative and quantitative.
- Lipids – qualitative.
- Determination of the iodine number of oil.
- Determination of the saponification number of oil.
- Determination of cholesterol using Liebermann- Burchard reaction.
- Proteins – qualitative.
- Isolation of protein.
- Determination of protein by the Biuret reaction.
- Determination of nucleic acids

Reference Books:

- T.G. Cooper: Tool of Biochemistry.
- Keith Wilson and John Walker: Practical Biochemistry.
- Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
- Thomas M. Devlin: Textbook of Biochemistry.
- Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
- Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed. PHI Learning.
- Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.*, W. H. Freeman.
- Mikes, O. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles
- Horwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

CHEMISTRY LABORATORY-VIII: POLYMER CHEMISTRY AND MOLECULAR MODELLING & DRUG DESIGN**POLYMER CHEMISTRY****List of Experiments for Practical****1. Polymer synthesis**

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
 - a. Purification of monomer
 - b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutyronitrile (AIBN)
2. Preparation of nylon 6,6/6
3. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
 - a. Preparation of IPC
 - b. Purification of IPC
 - c. Interfacial polymerization
4. Redox polymerization of acrylamide
5. Precipitation polymerization of acrylonitrile
6. Preparation of urea-formaldehyde resin
7. Preparations of novolac resin / resole resin.
8. Microscale Emulsion Polymerization of Poly(methyl acrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
 - (i) Polyacrylamide-aq.NaNO₂ solution
 - (ii) (Poly vinyl pyrrolidone (PVP) in water
2. Determination of the viscosity-average molecular weight of polyvinyl alcohol (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

**at least 7 experiments to be carried out.*

Reference Books:

1. M.P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed., Oxford University Press, 1999.
2. H.R. Allcock, F.W. Lampe & J.E. Mark, *Contemporary Polymer Chemistry*, 3rd ed. Prentice-Hall (2003)
3. F.W. Billmeyer, *Textbook of Polymer Science*, 3rd ed. Wiley-Interscience (1984)
4. J.R. Fried, *Polymer Science and Technology*, 2nd ed. Prentice-Hall (2003)
5. P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed.

John Wiley & Sons (2002)

6. L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)
7. M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. Oxford University Press (2005).

Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013)

MOLECULAR MODELING AND DRUG DESIGN

List of Experiments for Practical

1. Comparison of the optimized C-C bond lengths in ethane, ethene, ethyne and benzene.
Visualization of the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.
(a) Performing a conformational analysis of butane.
(b) Determination of the enthalpy of isomerization of *cis* and *trans* 2-butene.
2. Visualization of the electron density and electrostatic potential maps for LiH, HF, N₂, NO and CO and comments related to the dipole moments. Animation of the vibrations of these molecules.
3. (a) Relationship between the charge on the hydrogen atom in hydrogen halides with their acid character.
(b) Comparison of the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.
4. (a) Comparison of the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Noting the dipole moment of each molecule.
(b) Interpreting the relationship between shapes and their effects in the trend observed in boiling points: (118 °C, 100 °C, 108 °C, 82 °C, respectively).
5. Building and minimizing organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound:
(a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide.
6. (a) Determination of the heat of hydration of ethylene.
(b) Computing the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
7. Arranging 1-hexene, 2-methyl-2-pentene, (*E*)-3-methyl-2-pentene, (*Z*)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.
8. (a) Comparing the optimized bond angles of H₂O, H₂S and H₂Se.
(b) Comparing the HAH bond angles for the second row dihydrides and comparing with the results from qualitative MO theory.

Note: Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.

Reference Books:

1. Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
2. Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
3. Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

