SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)
AFFLIATED TO UNIVERSITY OF MUMBAI

Syllabus for SYBSc
Course: CHEMISTRY
With effect from the academic year 2019-20

Syllabus for Approval

Serial No.	Heading	Particulars
1	Title of course	S.Y.B.Sc. Chemistry
2	Passing marks	40%
3	Ordinance/Regulation (if any)	
4	No. of Semesters	Two
5	Level	UG
6	Pattern	Semester
7	To be implemented from Academic year	2019-20

Date:

BOS Chairperson
Dr. I. A. Mendes
Haram

Convener
Dr. Santosh

FACULTY: SCIENCE
COURSE: B.Sc.
SEMESTER III

Course Code	Title of the paper	Unit	Topic	Credits	L/Week
SBSCHE301	Physical and Analytical Chemistry	I	1.1 Chemical Thermodynamics – II 1.2 Electrochemistry – I	2	3
		II	2.1 Chemical Kinetics-II 2.2 Solutions		
		III	3.1Basics in Analytical Chemistry		
SBSCHE302	Inorganic Chemistry	I	1.1 Non directional bonding 1.2 Directional bonding- Valence Bond Theory 1.3 Directional bonding- Molecular Orbital Theory	2	3
		II	2.1Chemistry of boron compounds 2.2 Chemistry of silicon and germanium 2.3 Chemistry of nitrogen family		
		III	3.1Concept and scope of environmental chemistry 3.2 Toxicology 3.3 Environmental restoration		
SBSCHE303	Organic Chemistry	I	1.1 Investigation of reaction mechanism 1.2 Alkyl halides 1.3 Alcohols 1.4 Ethers 1.5 Epoxides	2	3
		II	2.1 Aliphatic Carbonyl Compounds 2.2 Aliphatic Carboxylic Acids & their Derivatives 2.3 Aliphatic Amines		
		III	3.1 Green Chemistry		
Practical Semester III					
SBSCHEP3	Chemistry Practical	-	-	3	9

SEMESTER IV

Course Code	Title of the paper	Unit	Topic	Credits	L/Week
SBSCHE401	Physical and Analytical Chemistry	I	1.1 Phase Equilibria 1.2 Electrochemistry – II	2	3
		II	2.1 Catalysis 2.2 Solid state		
		III	3.1 Titrimetric methods 3.2 Instrumental methods of analysis 3.3 Spectroscopy		
SBSCHE402	Inorganic Chemistry	I	1.1 Chemistry of transition elements 1.2 Co-ordination chemistry	2	3
		II	2.1 Bioinorganic chemistry 2.2 Organometallic Chemistry		
		III	3.1 Physicochemical parameters of water 3.2 Water treatment and purification 3.3 Metallurgy 3.4 Corrosion and protection of metals		
SBSCHE403	Organic Chemistry	I	1.1Nomenclature of polysubstituted aromatic compounds 1.2 Haloarenes 1.3 Phenols 1.4 Aromatic Carboxylic acids 1.5 Aromatic Sulfonic acids	2	3
		II	2.1 Aromatic nitro compounds 2.2 Aromatic amino compounds 2.3Aromatic aldehydes and ketones		
		III	3.1Industrial Organic Chemistry		
Practical Semester IV					
SBSCHEP4	Chemistry Practical	-	-	3	9

PAPER I
PHYSICAL AND ANALYTICAL CHEMISTRY
SEMESTER III

Unit I		
1.1	**Chemical Thermodynamics – II (8L)**	
	1.1.1	Second law of thermodynamics: Statement and concept of entropy.
	1.1.2	Free Energy Functions: Helmholtz Free Energy, Gibbs Free Energy, Variation of Gibbs Free Energy with pressure and temperature, Gibbs-Helmholtz Equation. (Numericals expected)
	1.1.3	Thermodynamics of open systems: Partial molal properties, Chemical potential and its variation with pressure and temperature, Gibbs- Duhem Equation.
	1.1.4	Vant Hoff Reaction Isotherm and Vant Hoff Reaction Isochore. (Numericals expected)
1.2	**Electrochemistry – I (7L)**	
	1.2.1	Conductivity, Equivalent and Molar Conductivity (Numericals expected) and their variation with dilution of weak and strong electrolytes, Debye- Huckel- Onsager Equation (no derivation) and its verification.
	1.2.2	Kohlrausch Law of Independent Migration of ions and its application: Determination of Ionization constant of a weak electrolyte, Solubility of a sparingly soluble salt and ionic product of water (Numericals expected)
	1.2.3	Transference Number and Its Experimental Determination using Moving Boundary Method (Numericals expected), Factors affecting transference number.
Unit II		
2.1	**Chemical Kinetics-II (7L)**	
	2.1.1	Classification of chemical reactions, Techniques for fast reactions: Stopped - flow method, Relaxation techniques and Flash Photolysis.
	2.1.2	Effect of temperature on the rate reaction: Arrhenius Equation (Numericals expected), Concept of energy of activation.
	2.1.3	Theories of Reaction rates: Collision and Activated Complex (Transition State) Theory of Bimolecular Reactions. Comparison between the two theories. (Qualitative treatment only)
2.2	**Solutions (8L)**	

	2.2.1	Thermodynamics of Ideal and Non-Ideal Solutions: Ideal Solutions and Raoult's Law (Numericals expected), Deviations from Raoult's Law, Non-ideal solutions, Vapour pressure: Composition and Temperature – Composition Curves of Ideal and Non-Ideal Solutions. Distillation of Solutions, Azeotropes and methods of separating them.
	2.2.2	Partial Miscibility of Liquids: Critical Solution Temperature, Effect of impurity on partial miscibility of liquids with respect to Phenol-Water, Triethanolamine-Water and Nicotine-Water systems.
	2.2.3	Immiscibility of Liquids: Principle and method of Steam Distillation. (Numericals expected)
Unit III		
3.1	**Basics in Analytical Chemistry(15 L)**	
	3.1.1	Language of Analytical Chemistry: Important terms and their significance in Analytical Chemistry, Analysis, determination, measurement, techniques, methods, procedures, protocols, validation, sensitivity, selectivity, robustness, ruggedness and scale of operation.
	3.1.2	Classical and non-classical methods of analysis: Their types and importance.
	3.1.3	Errors: Errors in analysis and its classification, Minimization of errors. Normal distribution curve. Precision and accuracy: Methods for their expression- Absolute error, relative error, mean, mode, median, range, deviation, relative average deviation, standard deviation, relative standard deviation, variance and coefficient of variance (Numericals expected)
	3.1.4	Significant figures and computation: Significant figures,
	3.1.5	Significance of zero in the computation of analytical data, Rules of computation. Calibration of glassware: Calibration of burette, pipette and standard flask.

SEMESTER III
PHYSICAL AND ANALYTICAL CHEMISTRY
PRACTICALS

1. To interpret the order of the reaction graphically for the given experimental data and calculate the specific reaction rate.
2. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentration of reactants.
3. To determine the energy of activation of acid catalysed hydrolysis of methylacetate.
4. To determine the rate constant for the alkaline hydrolysis of ethylacetate conductometrically.
5. To determine the dissociation constant of a weak acid conductometrically.

6. To verify Onsager equation of electrolytic conductance and to determine the equivalent conductance of a strong electrolyte at infinite dilution. 7. To titrate a strong acid against a strong base conductometrically. 8. To estimate copper in the given solution iodometrically.

SEMESTER IV

Paper I		
Unit I		
1.1	**Phase Equilibria (7L)**	
	1.1.1	Phases, Components and Degrees of Freedom of a System, Criteria of Phase Equilibrium, Gibbs Phase Rule: Thermodynamic derivation and its application.
	1.1.2	Phase diagram of one component system: Water and Sulphur.
	1.1.3	Phase diagram of two component system involving Eutectics: Lead- Silver system, Congruent melting point: Zinc-Magnesium System, Incongruent Melting point: Sodium-Potassium system.
	1.1.4	Clapeyron Equation and Clausius-Clapeyron Equation: Derivation and its importance in phase equilibrium. (Numericals expected)
1.2	**Electrochemistry – II (8L)**	
	1.2.1	Electrochemical Cells: Galvanic cells, Electrochemical conventions, Reversible and Irreversible cells.
	1.2.2	Types of electrodes, Standard electrode potential, Electrochemical series, Nernst Equations: Derivation and its applications. (Numericals expected).
	1.2.3	Calomel electrode, Glass electrode and Salt bridge – Principle, construction and working.
	1.2.4	pH determination using Glass electrode and Quinhydrone electrode. (Numericals expected)
	1.2.5	Equilibrium Constant and Thermodynamical Properties: ΔG, ΔH and ΔS from EMF data. (Numericals expected).
Unit II		
2.1	**Catalysis (7L)**	
	2.1.1	Types of Catalysis, Catalytic activity, selectivity. Promoters, Inhibitors and Poisons in Catalysis.
	2.1.2	Mechanism and Kinetics of Acid and Base catalyzed reactions, Effect of pH on the rate of reaction.
	2.1.3	Mechanism and Kinetics of Enzyme catalyzed Reaction. (Michaelis-Menten's Equation).
	2.1.4	Use of nanoparticles as catalysts.
2.2	**Solid State (8L)**	

	2.2.1	Laws of Crystallography.
	2.2.2	Symmetry elements, Unit cells, Bravais Lattice types, Weiss and Miller Indices.
	2.2.3	Characteristics of Simple Cubic, Body Centered Cubic and Face Centered Cubic Lattices, Interplanar distances of basic planes in these lattices. (Numericals expected)
	2.2.4	Use of X-rays in crystal structure determination, X-ray Diffraction method, Bragg's equation (Numericals expected), Structure of NaCl and KCl, Determination of Avogadro's Number (Numericals expected).

Unit III		
3.1	**Titrimetric methods (3L)**	
	3.1.1	Terms involved in titrimetric methods of analysis, conditions suitable for titrimetry
	3.1.2	Types of titrimetry: Neutralisation, Redox (iodometry, iodimetry), Precipitation and Complexometric titrations
3.2	**Instrumental methods of analysis (4L)**	
	3.2.1	Basic concepts in Instrumental methods: Relation between the analyte, stimulus and measurement of change in the observable property.
	3.2.2	Types of Analytical Instrumental methods (only principle) based on: (i) Optical Interaction: UV- Visible Spectroscopy, Polarimetry (ii) Electrochemical interaction: Potentiometry, pH metry and Conductometry (iii) Thermal interaction: Thermogravimetry
3.3	**Spectroscopy (8L)**	
	3.3.1	Instrumentation for absorption spectroscopy: Colorimeters and spectrophotometers, Block diagram of single and double beam colorimeter and spectrophotometer, Principle, construction and working.
	3.3.2	Applications of UV-Vis spectroscopy: (i) Qualitative analysis (ii) Quantitative analysis by calibration curve method.
	3.3.3	Photometric titrations: Principle, working, types of curves and applications.

SEMESTER IV
PHYSICAL AND ANALYTICAL CHEMISTRY
PRACTICALS

1. To statistically evaluate the given analytical data for its accuracy and precision.
2. To determine the standard EMF and the standard free energy of the Daniel cell potentiometrically.
3. To determine the amount of HCl in the given sample potentiometrically using Quinhydrone electrode.

4. To determine the amount of Fe (III) in the given solution by titrating against $K_2Cr_2O_7$ potentiometrically.
5. To conduct a pH titration of a weak acid against a strong base and to find out its dissociation constant.
6. To determine the amount of aspirin in commercial sample by colorimetry.
7. To determine the concentration of Cu (II) in the given solution by colorimetry.
8. To determine the percentage of optically active substance in a given solution (glucose/sucrose) polarimetrically.

REFERENCE-Theory

1. Physical Chemistry, G.M. Barrow. Tata McGraw-Hill (2007)
2. Physical Chemistry, G.W. Castellan. Narosa 4th Edition (2004)
3. General Chemistry, J.C Kotz., P.M. Treichel & Townsend. Cengage Learning Inida Pvt. Ltd., New Delhi (2009)
4. University Chemistry, B.H. Mahan. Narosa 3rd Edition (1998)
5. General Chemistry, R.H. Petrucci. Macmillan Publishing Co., New York 5th Edition (1985)
6. A textbook of Physical Chemistry, K.L. Kapoor. Macmillan Publishing Co., New Delhi 3rd Edition (2001)
7. Analytical Chemistry, G. L. David Krupadanam, D.Vijaya Prasad and others, Universities Press, (2001).
8. Modern Analytical Chemistry, David Harvey. Mc Graw-Hill International Edition (2000)
9. Fundamental of Analytical Chemistry, Skoog, West, Holler and Crouch, Seventh Edition (2010)
10. Analytical Chemistry, D. Kealey and P.J. Haines, First Edition (2002).
11. Quality Assurance in Analytical Chemistry, Elizabeth Prichard and Vicki Barwick, John Wiley and Sons, Ltd (2007).
12. Analytical Chemistry, Open Learning series (ACOL)-Wiley India Edition.(2008)

REFERENCE- Practicals

1. Senior Practical Physical Chemistry, B.D. Khosla, V.C. Garg and A. Gulati, R. Chand and Co., New Delhi (2011)
2. Experiments in Physical Chemistry, C.W. Garland, J.W. Nibler and D.P. Shoemaker, McGraw-Hill New York 8th Edition (2003)

3. Experimental Physical Chemistry, A.M. Halpern and G.C. McBane, W.H. Freeman and Co., New York (2003)
4. Experimental Physical Chemistry, V.D. Athawale and P. Mathur, New Age International, New Delhi (2001)
5. Practical Physical Chemistry, B. Vishwanathan and P.S. Raghavan Viva Books (2017)
6. Systematic Experimental Physical Chemistry by S.W. Rajbhoj and T.K. Chondhekar Anjali Publication (2013)
7. Physical Chemistry – A Lab Manual S.K. Sinha, Narosa Publication (2014)
8. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham et.al.,Sixth Edition, Pearson Publication.

PAPER II
INORGANIC CHEMISTRY
SEMESTER III

UNIT I		
1.1	**Non-Directional Bonding (4L)**	
	1.1.1	Ionic Bond: Introduction, conditions for the formation of an ionic bond.
	1.1.2	Ionic crystals: definitions-crystal lattice, lattice points, unit cell, lattice parameters, types of ionic crystals
	1.1.3	Lattice Energy: Borne-Lande equation, Kapustinski equation, Born-Haber Cycle and its application (Numericals expected)
1.2	**Directional Bonding –Valence Bond theory(6L)**	
	1.2.1	Covalent Bonding: Valence Bond Theory- introduction and basic tenets.
	1.2.2	Formation of H_2: Interaction between two hydrogen atoms and the potential energy diagram of the resultant system, corrections applied to the system of two hydrogen atoms
	1.2.3	Hybridization and types of hybrid orbitals- *sp, sp*^{2}*,sp*^{3}*,sp*^{3}*d, sp*^{3}*d*^{2}
	1.2.4	Equivalent and Non-Equivalent hybrid orbitals
	1.2.5	Limitations of VBT
1.3	**Directional Bonding -Molecular Orbital Theory(5L)**	
	1.3.1.	Introduction to MOT, definitions- bonding, anti-bonding and non-bonding molecular orbitals
	1.3.2.	LCAO- MO approach to homonuclear diatomic molecules H_2 to Ne_2 (calculation of bond order and magnetic property)

	1.3.3 1.3.4	Bond Order and Magnetic property of species of O_2: O_2^{+} O_2^{1-},O_2^{2-} LCAO- MO approach to heteronuclear diatomic molecules: HCl, NO, CO (calculation of bond order and magnetic property)
UNIT II		
2.1	**Chemistry of Boron compounds (4L)**	
	2.1.1 2.1.2 2.1.3	Electron deficient compounds: BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications. Preparation of simple boranes like diborane and tetraborane, Structure and bonding in diborane and tetraborane (2e-3e bonds) Preparation and applications of borax
2.2	**Chemistry of Silicon and Germanium (5L)**	
	2.2.1 2.2.2 2.2.3 2.2.4 2.2.5	Silicon compounds: Occurrence, structure and inertness of SiO_2 Preparation and structure of $SiCl_4$ Occurrence and extraction of Germanium Preparation of pure Silicon and Germanium Uses of Silicon and Germanium
2.3	**Chemistry of Nitrogen family (6L)**	
	2.3.1 2.3.2 2.3.3	Trends in chemical reactivity of compounds of elements of group 15- hydrides, halides and oxides Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4. Synthesis of ammonia by Bosch – Haber process: physicochemical principles
UNIT III		
3.1	**Concept and scope of environmental Chemistry (5L)**	
	3.1.1 3.1.2 3.1.3 3.1.4	Components of the environment: biotic and abiotic. Composition of various segments of the environment: atmosphere, hydrosphere, lithosphere, biosphere. Natural Chemical processes: Carbon, nitrogen and oxygen cycles Environmental pollution: air pollution, soil pollution and water pollution – effects and control measures
3.2	**Toxicology (8L)**	
	3.2.1 3.2.2	Concept, biochemical and physiological effects Toxicity of chemicals i) Metals: As(III), Hg(II), Pb(II), Cd(II), Cr(VI) - origin in the environment, ill effects, control measures ii)Non-metals: oxides of carbon, nitrogen and sulphur (photochemical smog and green house gases)

	3.2.3	Case studies: London smog, Bhopal gas tragedy, Minamata disease, Chernobyl disaster
3.3	**Environmental restoration (2L)**	
	3.3.1	Concept of 4 R's: Reduce, Reuse, Recycle and Recover

SEMESTER III
INORGANIC CHEMISTRY
PRACTICALS

1. Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions using the H_2S scheme for precipitation of cations (minimum 6 mixtures)
   Cations (from amongst): Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, Fe^{2+}, Ni^{2+}, Mn^{2+}, Mg^{2+}, Al^{3+} ,Cr^{3+},$Cd^{2+,}$ $Fe^{3+,}Zn^{2+}$, Co^{2+}, Sb^{3+},K^{+}, NH_4^{+}
   Anions (from amongst):CO_3^{2-}, S^{2-}, $SO_3^{2-,}$ NO_2^{-}, $NO_3^{-,}$ Cl^{-}, Br^{-}, I^{-}, SO_4^{2-}, $PO_4^{3-,}$ CrO_4^{2-}, $Cr_2O_7^{2-}$
2. To determine the amount of magnesium ions (as magnesium oxinate) in the given solution gravimetrically
3. To determine the amount of magnesium ions in the given solution complexometrically

SEMESTER IV

	UNIT I	
1.1	**Chemistry of transition metals (8L)**	
	1.1.1	Position in the periodic table, natural occurrence, principal ores and minerals of elements of the first transition series.
	1.1.2	Oxidation states, origin of colour of transition metals and their compounds: d-d transitions and charge transfer
	1.1.3	Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital momentum of electrons, equation for spin only and spin-orbital magnetism terms of Bohr magnetons (Derivation not expected), Reasons for quenching of orbital momentum of electrons
	1.1.4	Uses of transition elements
1.2	**Coordination Chemistry (7L)**	

	1.2.1 1.2.2 1.2.3 1.2.4 1.2.5	Introduction, basic terms, types of ligands, nomenclature of co-ordination compounds, isomerism and its types Werner's theory of coordination, effective atomic number rule Nature of the Metal-Ligand Bond:Valence Bond Theory-hybridisation -sp^3, dsp^2, sp^3d^2,d^2sp^3(Inner and outer orbital complexes of Mn(II), Fe(II), Fe(III),Co(II),Co(III),Ni(II), Cu(II), Zn(II) with ligands like aqua, ammonia,cyanide and halides) Limitations of V.B.T with respect to co-ordination compounds. Uses of coordination compounds: medicinal, biological, industrial and as laboratory reagents
UNIT II		
2.1	**Bioinorganic chemistry (7L)**	
	2.1.1 2.1.2	Introduction, essential and non-essential elements and their role in biological systems Na(I) and K(I)- ion pumps (mechanism), Fe(II) and Fe(III) [oxygen transport (mechanism), electron transfer and iron storage] and Mg(II) [photosynthesis (mechanism)]
2.2	**Organometallic Chemistry (8L)**	
	2.2.1 2.2.2 2.2.3	Introduction, definition, classification based on heptacity and nature of metal –carbon bond, methods of preparation Applications of organometallic compounds in organic synthesis as catalysts: Zeigler Natta and Wilkinson (with mechanism) Metal carbonyls: bonding, properties and methods of preparation, eighteen electron rule and its applications and exceptions
UNIT III		
3.1	**Physicochemical parameters of water (3L)**	
	3.1.1	Dissolved oxygen, chemical oxygen demand and its measurement, biochemical oxygen demand and its measurement, pH, total dissolved salts, total suspended solids, total hardness, effect of these parameters on the ecosystem
3.2	**Water treatment and purification (4L)**	
	3.2.1	Effluent treatment plants: primary, secondary, tertiary, sludge disposal Treatment of industrial effluent from electroplating and tannery

	3.2.2	industry
3.3	**Metallurgy (4L)**	
	3.3.1 3.3.2	Basic steps involved in metallurgy Extraction of metals i) Cu by pyrometallurgy and electrolysis ii) Ag by hydrometallurgy iii) Al by electrometallurgy
3.4	**Corrosion and Protection of metals (4L)**	
	3.4.1 3.4.2.	Introduction, types of corrosion, Electrochemical theory of corrosion (Derivation not expected) Importance of protection of metals from corrosion, methods of protection- coating, electroplating, cathodic protection, anodizing, sacrificial coating

SEMESTER IV
INORGANIC CHEMISTRY
PRACTICALS

1. To determine the amount of nickel ions (as nickel-dmg) in the given solution gravimetrically.
2. To determine the amount of barium ions (as barium chromate) in the given solution gravimetrically.
3. To estimate the amount of zinc ions in solution complexometrically.
4. To determine the total hardness of water.
5. To determine the dissolved oxygen in the given water sample.
6. To determine the chemical oxygen demand of the given water sample.
7. To determine the percentage composition of calcium oxide / magnesium oxide in the given dolomite sample complexometrically.
8. To determine the percentage of nickel in the given sample of cupronickel alloy/synthetic sample complexometrically.

REFERENCE–Theory

1. Concise Inorganic Chemistry, J D Lee, Blackwell Science Ltd, 5th edition,1996
2. Principles of structure and reactivity, James Huheey, Addison Wesley publishing company, 4th edition, 1993
3. Environmental Chemistry, A K De, New Age publication, 6thedition, 2006

4. Fundamental concepts of environmental chemistry, G.S. Sodhi, Narosa, 3rd edition,2008

REFERENCE –Practical

1. Vogel's qualitative inorganic analysis, G. Svehla,B. Sivasankar, Pearson Education India 7th edition,2012
2. Semi-micro qualitative analysis, Velcher and Hahn, East West Press, 1963
3. A textbook of quantitative inorganic analysis, Arthur I. Vogel, Longman, 3rd edition,1961

Paper III
Organic Chemistry
Semester III

	Unit I	
1.1	**Investigation of reaction mechanisms (4L)**	
		Product analysis including cross-over products, trapping of intermediates,

		isotopic labelling, kinetic and stereochemical evidence.
1.2	**Alkyl halides (3L)**	
		Nucleophilic substitution reactions: S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and factors affecting the rates of nucleophilic substitution reactions-nature of substrate, solvent, nucleophilic reagent and leaving group.
1.3	**Alcohols (3L)**	
	1.3.1	Preparation: Hydration, Oxymercuration-Demercuration and hydroboration of alkenes, reduction of aldehydes and ketones and using Grignard reagent.
	1.3.2	Properties: Hydrogen bonding- types and effect on different properties.
	1.3.3	Reactions of alcohols: Alcohols as acids, conversion of alcohols into mesylates and tosylates and alkyl halides.
1.4	**Ethers (2L)**	
	1.4.1	Preparation: Dehydration of alcohols (mechanism), Williamson synthesis (mechanism).
	1.4.2	Reactions: Acid catalyzed cleavage reaction with HX (mechanism).
	1.4.3	Applications: Ethers and crown ethers (12-crown-4 and 18-crown-6).
1.5	**Epoxides (3L)**	
	1.5.1	Preparation: Oxidation of olefins, Reaction of per acids with olefins, from vicinal halohydrins.
	1.5.2	Reactions: Reactivity, Ring opening reactions by nucleophiles i) In acidic conditions: hydrolysis, reaction with – HX, alcohol, HCN ii) In neutral or basic conditions: Reaction with ammonia, amines, metal cyanides and alkoxides.
	1.5.3	Applications of epoxides.
	Unit II	
2.1	**Aliphatic Carbonyl Compounds (4L)**	
	2.1.1	Structure and reactivity of aldehydes and ketones
	2.1.2	Preparation: Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, from esters using Grignard reagent.
	2.1.3	Reactions of aldehydes and ketones: General mechanism of nucleophilic addition and acid catalysed nucleophilic addition. Reactions with $NaHSO_3$, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2,4-Dinitrophenyl hydrazine, $LiAlH_4$ and $NaBH_4$.
	2.1.4	Keto-enol tautomerism, Mechanism of acid and base catalysed enolization.
2.2	**Aliphatic Carboxylic Acids and their Derivatives (8L)**	
	2.2.1	Structure and physical properties: acidity of carboxylic acids, effects of substituents on acid strength of aliphatic carboxylic acids.
	2.2.2	Preparation of carboxylic acids: oxidation of alcohols, carbonation of Grignard reagent and hydrolysis of nitriles.
	2.2.3	Reactions: Mechanism of nucleophilic acyl substitution and acid-catalysed

		nucleophilic acyl substitution. Relative reactivity of acyl compounds. Interconversion of acid derivatives by nucleophilic acyl substitution. Salt formation, decarboxylation, Reduction of carboxylic acids with $LiAlH_4$, diborane, Hell-Volhard-Zelinskyreaction, conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides. Claisen condensation and Dieckmann condensation
2.3	**Aliphatic Amines (3L)**	
	2.3.1 2.3.2 2.3.3	Basicity and effect of substituents on basicity of aliphatic amines. Preparation: Chemical reduction using Fe-HCl, Sn-HCl, Zn-acetic acid, reduction of nitriles, alkylation of ammonia, reductive amination, Hofmann degradation reaction. Reactions: Salt formation, N-alkylation, Hofmann elimination reaction, reaction with nitrous acid, carbylamine reaction.
	Unit III	
3.1	**Green Chemistry: (15L)**	
	3.1.1 3.1.2 3.1.3	Green chemistry: Definition, need, importance. 12 principles of green chemistry with relevant examples. Concepts and simple calculations based on Yield and Selectivity, E-factor, Atom economy. Factors governing the design of Green synthesis: i) Green starting materials-commodity chemicals from glucose. ii) Green reactions-halide free synthesis of aromatic amines. iii) Green reagents-selective methylation using dimethyl carbonate. iv) Green chemical solvents-use of supercritical carbon dioxide. v) Green chemical products-synthesis of thermal polyaspartates. vi) Green chemistry and catalysis-novel homogenous, heterogenous and enzymatic catalysts in industry, Catalytic liquid phase selective hydrogenation of nitrobenzene to p-aminophenol, liquid phase air oxidation of p-cresol to p-hydroxybenzaldehyde. Alternative methods involving Green synthesis i) Green synthesis of adipic acid, catechol, disodium iminodiacetate (alternative to Strecker Synthesis) ii) Green synthesis of a compostable and widely applicable plastic -poly lactic acid made from corn iii) Microwave assisted reactions: a) In water: Hofmann Elimination, methyl benzoate to benzoic acid, b) In organic solvents: Diels-Alder reaction. iv) Ultrasound assisted reactions: Sonochemical Simmon- Smith reaction (Alternative to Iodine)

Semester III
ORGANIC CHEMISTRY
PRACTICALS

Preparation of derivatives

1. Acetyl derivative of phenols/amine
2. Bromination of phenols/amines
3. 2,4-DNPH derivative of aldehydes/ketones
4. Oxidation of aldehydes
5. Nitro derivatives of aromatic hydrocarbons
6. Hydrolysis of esters

Green Chemistry experiments (any two)

1. Microwave assisted one-pot synthesis of Coumarin by Knovenagal reaction
2. Calculation of the atom economy for the preparation of propene from N, N dimethyl N -propanamine and propanol
3. Benzoin condensation using thyamine hydrochloride as a catalyst instead of cyanide.
4. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Semester IV

	Unit I
1.1	**Nomenclature of polysubstituted aromatic compounds(2L)**

		Benzene, Naphthalene and anthracene containing different functional groups.
1.2	**Haloarenes (4L)**	
	1.2.1	Preparation of Haloarenes: Halogenation of benzene and substituted benzenes with molecular halogens (mechanism).
	1.2.2	Reactions of haloarenes: Lack of reactivity of arylhalides under S_Nl and S_N2 reactions. General mechanism (addition – elimination) of aromatic nucleophilic substituents on the reaction – hydrolysis and amination of haloarenes. Benzyne intermediate mechanism (elimination – addition) of aromatic nucleophilic substitution reaction (cine substitution)
	1.2.3	Applications of aromatic halogen compounds. Ullmann reaction.
1.3	**Phenols (3L)**	
	1.3.1	Preparation of phenols: i) halobenzenes, ii) aromatic sulfonic acids (benezene and naphthalene sulfonic acids) iii) isopropyl benzene by hydroperoxide method.
	1.3.2	Reaction of phenols: Acidity of phenols – effect of substituents on acidity of phenols. Salt formation, Etherification – direct reaction with alcohol, Williamson Synthesis, O-acylation, Halogenation, Nitration, Fries rearrangement of aryl carboxylates, Claisen rearrangement of allyloxyarenes.
	1.3.3	Applications of phenols.
1.4.	**Aromatic Carboxylic acids and their derivatives (3L)**	
	1.4.1	Preparation of mono and di-carboxylic acids: Preparation by side chain oxidation of alkyl benzenes, reaction of Grignard reagents with solid carbon dioxide, hydrolysis of aryl nitriles, Kolbe-Schmitt reaction (mechanism)
	1.4.2	Reactions of aromatic carboxylic acids: Acidity, Effect of substituent on the acidity of benzoic acid, acid catalyzed esterification, Reduction and decarboxylation.
	1.4.3	Applications of aromatic carboxylic acids.
1.5	**Aromatic sulfonic acids (3L)**	
	1.5.1	Preparation of aromatic sulfonic acids: Commonly used sulfonating agents. Sulfonation of benzene (with mechanism), monosubstituted benzene and naphthalene.
	1.5.2	Reactions: Acidity of arene sulfonic acids, comparative acidity of carboxylic acids and sulfonic acids, salt formation, desulfonation, IPSO substitution, -SO_3H as solubilizing and blocking group, preparation of sulfonate ester.
	1.5.3	Uses of p-TSA, sulfonated polystyrene, naphthalene monosulphanilic acids.
	Unit II	
2.1	**Aromatic nitro compounds (3L)**	
	2.1.1	Preparation: Nitration using mixed acid, Preparation of mononitro and dinitrocompounds by nitration of benzene (mechanism), nitrobenzene, toluene,

		chlorobenzene, naphthalene, anisole.
	2.1.2	Reactions: Reduction of nitrocompounds under different conditions.
	2.1.3	Applications of nitro compounds: Preparation of amines and explosives
2.2	**Aromatic amino compounds (5L)**	
	2.2.1	Preparation: Reduction of aromatic nitro compounds using catalytic hydrogenation, metal reduction– Fe-HCl, Sn-HCl, Zn-acetic acid, Selective reduction of dinitrobenzene, Hofmann bromamide reaction.
	2.2.2	Reactions: Basicity of aromatic amines – effect of substituents on basicity of aniline, salt formation, N-alkylation, N-acylation, halogenation, reductive alkylation, diazotization of aromatic primary amines (mechanism)
	2.2.3	Reactions of aryl diazonium salts-Sandmeyer, Gattermann and Gomberg reactions, Replacement of diazo group by -H, -OH, -CN, -I, -F. Azo-coupling reaction with phenols/naphthols and aromatic amines. Reduction of diazonium salt to aryl hydrazine. Formation of azo and hydrazo benzenes.
2.3	**Aromatic Aldehydes and Ketones**: **(7L)**	
	2.3.1	Preparation of aromatic aldehydes: Preparation using CO (Gattermann-Koch reaction), HCN (Gattermann reaction), DMF/$POCl_3$ (Vilsmeier – Haack reaction), Reimer-Tiemann reaction (mechanism), Rosenmund reaction.
	2.3.2	Preparation of aromatic ketones: Friedel-Crafts acylation using acid chloride and acid anhydride (mechanism)
	2.3.3	Reactions: Reactions with- ammonia and amines, hydroxylamine, phenylhydrazine, hydrogen cyanide, sodium bisulphate. Reactions with mechanism: Knoevengel reaction, Claisen-Schmidt reaction, Benzoin reaction, Cannizzaro reaction.
	2.3.4	Applications of aromatic aldehydes and ketones.
	Unit III	
	3.1 Industrial Organic Chemistry(15L)	
	3.1.1	Economics of Chemical Processes: Capital Costs, Production Costs, Research and Development Costs, Effect of Scale on Costs.
	3.1.2	Basic Raw Material for Organic Chemicals: Coal, Petroleum, Natural Gas
	3.1.3	Chemical Processing Technology: Batch and Continuous processing, Catalytic Reactors, Yield and Conversion in Chemical Processes
	3.1.4	Reactions of Alkanes and cycloalkanes: Petroleum Refining reactions, Catalytic Alkylation, Catalytic Isomerisation, Catalytic reforming, Catalytic Cracking, Hydrocracking
	3.1.5	Petrochemical Processes: Thermal cracking of Alkenes, Acetylene Processes, Catalytic Reforming for Aromatics, Steam reforming
	3.1.6	Intermediate Dyes and their applications: raw materials for dye industry, Nitration - Unit Process in the manufacture of nitrobenzene including flow chart, Sulfonation - Unit Process of sulfonation including flow chart of benzene sulfonic acid and 1 & 2 naphthalene sulfonic acid.

Semester IV
ORGANIC CHEMISTRY
PRACTICALS

Systematic Qualitative Analysis of organic compounds

With mono and bifunctional groups. (acids, phenols, alcohols, aldehydes, ketones, amides, nitro, amines, esters, hydrocarbons, thioamides etc). Minimum of 8 compounds

Organic Estimations

1. Estimation of equivalent weight of acid.
2. Estimation of acetamide.
3. Estimation of acetone.
4. Estimation of aniline.

References-Theory

1. Organic Chemistry, T.W. Graham Solomons, C. B. Fryhle & S.A Dnyder, John Wiley & Sons Asia 8th Edition (2004).
2. Fundamentals of Organic Chemistry J.E Mc Murry, Cengage Learning India 7th Edition (2011).
3. Guide to Mechanism in Organic Chemistry, P. A Sykes, Orient Longman, New 6th Edition Delhi (1986)
4. Organic Chemistry, Paula Yurkanis. Bruice., Pearson Education, Inc. 3rd Ed (1998)
5. Organic Chemistry R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, Pearson Education Inc. 7th Edition, (2011)
6. An Introduction to Industrial Organic Chemistry, Peter Wiseman, Applied Science Publishers Ltd. (1972)
7. Chemical Process Industries, D.K. Shreve, J.A. Brink, McGraw-Hill 4th Edition (1977)
8. New Trends in Green Chemistry, V.K. Ahluwalia, M.R. Kidwai, Anamalaya Publishers (200?)
9. Green Chemistry, V.K. Ahluwalia, Narosa Publication House (2011)
10. Green Chemistry Theory and Practicals, P.T. Anasthus, J.K. Warner, Oxford University Press (1998)

References- Practicals

1. Textbook of Practical Organic Chemistry, A.I Vogel, A.R. Tatchell, B.S. Furnis, A.J..J Hanaford, & P.W.G Smith, Prentice-Hall, 5th Edition, (1996)
2. Practical Organic Chemistry, F.G. Mann and B.C. Saunders Orient-Longman, (1960)
3. Comprehensive Practical Organic Chemistry, V.K. Ahluwalia and R. Aggrawal, University Press

Semester End Exam (75 marks)

Paper Pattern for Chemistry
S.Y.B.Sc.

Q1) Unit I: Answer any four of the following. (4 out of 6) [20 marks]
Q2) Unit II: Answer any four of the following. (4 out of 6) [20 marks]
Q3) Unit III: Answer any four of the following. (4 out of 6) [20 marks]

Q4) A) Unit I: Do as Directed. Objective type (5 out of 7) [5 marks]
Q4) B) Unit II: Do as Directed. Objective type (5 out of 7) [5 marks]
Q4) C) Unit III: Do as Directed. Objective type (5 out of 7) [5 marks]

Internal Assessment (25 Marks)

20 Marks: Written Test (10Marks objective +10 Marks subjective)
5 Marks: Attendance & Active Participation in class