THREE YEARS DEGREE COURSE

B.Sc. SYLLABUS

CHEMISTRY

2013-2014

SNDT WOMEN'S UNIVERSITY

B.Sc. Chemistry					
Class	Sem	Paper	Title	Marks	Credit
F.Y.B.Sc.	I	102101	Inorganic Chemistry	50	2
		102102	Organic Chemistry	50	2
		102201	Practical based on 102101 & 102102	50	2
			Sub Total	150	6
F.Y.B.Sc.	II	202101	Physical Chemistry	50	2
		202102	Inorganic Chemistry	50	2
		202201	Practical based on 202101 & 202102	50	2
			Sub Total	150	6
			Total	300	12
S.Y.B.Sc.	III	302101	Organic Chemistry	75	3
		302102	Physical Chemistry	75	3
		302201	Practical based on 302101 & 302102	75	3
			Sub Total	225	9
S.Y.B.Sc.	IV	402101	Inorganic Chemistry	75	3
		402102	Physical Chemistry	75	3
		402201	Practical based on 402101 & 402102	75	3
			Sub Total	225	9
			Total	450	18
T.Y.B.Sc.	VI	502101	Physical Chemistry	75	3
		502102	Organic Chemistry	75	3
		502103	Inorganic Chemistry	75	3
		502104	Analytical Chemistry	75	3
		502201	Practical based on 502101 & 502102	75	3
		502202	Practical based on 502103 & 502104	75	3
			Sub Total	450	18
T.Y.B.Sc.	VI	602101	Physical Chemistry	75	3
		602102	Organic Chemistry	75	3
		602103	Inorganic Chemistry	75	3
		602104	Analytical Chemistry	75	3
		602201	Practical based on 602101 & 602102	75	3
		602202	Practical based on 602103 & 602104	75	3

			Sub Total	450	18
			Total	900	36
			Grand Total	1650	66

First Year-First Semester

Paper 102101 Inorganic Chemistry 2 Credits, 50 Marks(30Hrs)

3 Hrs / Week

I	Atomic Structure	08Hrs.
II	Periodic Properties	07Hrs.
III	S - Block Elements	08 Hrs.
IV	Theory of volumetric analysis	07Hrs.

Paper 102102 Organic Chemistry 2 Credits, 50 Marks(30 Hrs)

3 Hrs / Week

I	Structure and Bonding	05 Hrs.
II	Mechanism of Organic reactions	06Hrs.
III	Stereo – Chemistry	06 Hrs.
IV	Alkanes, Alkenes	07Hrs.
V	Arenes and Aromaticity	03 Hrs.
VI	Alkyl and Aryl Halides	03 Hrs.

Paper 102201 Lab Course Inorganic & organic Chemistry

2 Credits, 50 Marks(30Hrs) 3 Hrs / Week

First Year - Second Semester

Paper 202101 Physical Chemistry 2 Credits, 50 Marks(30Hrs)

3 Hrs / Week

I	Gaseous State	06Hrs.
II	Chemical Kinetics and Catalysis	12 Hrs.
III	Liquid State	03Hrs.
IV	Solid state	06 Hrs.
V	Colloidal State	03 Hrs.

Paper 202102 Inorganic Chemistry 2 Credits, 50 Marks(30 Hrs)

3 Hrs / Week

I	Chemical Bonding	12 Hrs.
II	Chemistry of Noble Gases& P Block elements	10 Hrs.
III	Theory of Qualitative Analysis	08 Hrs.

Paper 202201 Lab Course Physical & Inorganic

2 Credits, 50 Marks(30 Hrs) 3 Hrs / Week

First / Second Semester

Question Paper Pattern for Theory

Time : 2 Hrs Marks : 50

Note: All Questions are Compulsory

Q.1	Attempt any SEVEN of the following [(i) to (x)]	--- 14 Marks
Q.2	Attempt any THREE of the following [(i) to (v)]	--- 12 Marks
Q.3	Attempt any THREE of the following [(i) to (v)]	--- 12 Marks
Q.4	Attempt any THREE of the following [(i) to (v)]	--- 12 Marks

First / Second Semester

Question Paper Pattern for Practical

Lab Course **Time :4 Hrs.**

Marks : 50

Q.1	Unit-I	--- 20 Marks
Q.2	Unit-II	--- 20 Marks
Q.3	Record Book and Viva	--- 10 Marks

First Year - First Semester

Paper 102101 Inorganic Chemistry 2 Credits, 50 Marks (30 Hrs)

3 Hrs / Week

I. Atomic Structure: 08 Hrs

Atomic orbital's, Quantum numbers, Heisenberg uncertainty principle, shapes of s, p, d orbital's. Aufbau and Pauli exclusion principles.Hund's multiplicity rule.Electronic configurations of the elements, Bohr's atomic model (Qualitative aspect only).

II. Periodic Properties: 07 Hrs

Atomic and Ionic radii, Ionization Energy, Electron affinity and Electro negativity.Trends in periodic table and application in predicting and explaining the chemical behaviour.

III.S-Block Elements: 08 Hrs

Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems.

IV.Theory of volumetric Analysis : 07 Hrs

Types of titrations, volumetric apparatus, calibration of pipette and burette. Indicators used in pH - titrations, oxidizing agents used in titrations. Theory of Internal, External and self indicators for redox titration.

Paper 102102 Organic Chemistry 2 Credits, 50 Marks(30 Hrs)

3 Hrs / Week

I. Structure and Bonding : 05 Hrs

Localized and delocalized chemical bond; charge transfer complexes, resonance, hyper conjugation, inductive effect, hydrogen bonding, conjugative effect, steric effect.

II. Mechanism of Organic Reactions: 06 Hrs

Homolytic and heterolytic bond breaking.Types of reagents eletrophiles and nucleophiles.Types of organic reactions.Energy considerations.Reactive intermediates - carbocations, carbanions, free radicals (with two examples each) Methods of determination of reaction mechanism

(product analysis, intermediates, isotope effects, kinetic and stereo - chemical studies with two examples each).

III. Stereochemistry of Organic Compounds : 06 Hrs

Concept of Isomerism - Types of isomerism

Optical Isomerism - elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythrodiastereomers, meso compounds.

Relative and absolute configuration, sequence rules, D, L and R, S systems of nomenclature.

Geometric Isomerism - Determination of configuration of geometric isomers. E and Z system of nomenclature.

IV.Alkanes : 07Hrs

Methods of formation (Koble reaction, Corey - House reaction and decarboxylation of carboxylic acids) Physical properties and Chemical reactions of alkanes

Alkenes : Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides. The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes - mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration and oxidation with KMnO4. Polymerization of alkenes with one example each.

V.Arenes and Aromaticity: 03 Hrs

Nomeclature of benzene derivatives.The aryl group. Aromatic nucleus and side chain structure of benzene : molecular formula and Kekule structure. Resonance Structure, MO Picture.

Aromaticity : The Huckel rule, aromatic ions Aromatic electrophilic substitution: General Pattern of the mechanism (Nitration, halogenations and Sulphonation) and Friedel Crafts reaction.

VI.Alkyl and Aryl halides: 03 Hrs

Polyhalogen Compounds: Chloroform, Carbon tetrachloride. Methods -formation of aryl halides, nuclear and side chain reaction.

Paper 102201 Lab Course 2 Credits, 50 Marks(30 Hrs)

2 Hrs / Week

Unit 1

Inorganic Volumetric Analysis:

I. Preparation of 0.1N NaOH solution and its standardization by given succinic acid

II. Standardization of NaOH solution by 0.1N oxalic acid solution and estimation of given HCl solution.

III. Estimation of Ferrous ion (Fe2+) from the given solution using supplied KMnO4 soln.

IV. Estimation of Sodium Carbonate and Sodium Bicarbonate from the given sample using o.1 N HCL solution.

Unit 2

I Organic Qualitative Analysis:

Nature, Elemental Analysis, Functional group, Physical constant of :

* Benzoic acid, *Acetone, * β-naphthol, * m-nitroaniline,

* Naphthalene, * Acetanilide, *Methyl Acetate, *Nitrobenzene.

First Year - Second Semester

Paper 202101 Physical Chemistry 2 Credits, 50 Marks(30 Hrs)

3 Hrs / Week

I. Gaseous State: 06 Hrs

Postulates of kinetic theory of gases, kinetic gas equation, Deduction of Gas Laws : Boyles Law, Charles Law, Grahams Law of diffusion, Avogadro's hypothesis, deviation from ideal behaviour, van der Waals equation of state. Critical Phenomena : PV isotherms of real gases.

II.Chemicals Kinetics and Catalysis: 12 Hrs

Chemical Kinetics and its scope, rate of reaction, factors influencing the rate of reaction - concentration, temperature, pressure, solvent, light, catalyst concentration dependence of rates. Derivation of rate law and characteristics of simple chemical reactions - zero order, first order, second order, Pseudo first order, half life.Effect of temperature on rate of reaction.Arrhenius equation, concept of activation energy.Catalysis : Definition, types, and characteristics of catalysis, homogeneous, heterogeneous catalysis - Enzyme catalysis and its application.

III.Liquid State: 03 Hrs

Intermolecular forces, structure of liquids (a qualitative description). Difference between solids, liquids and gases. Liquid Crystals: Classification, structure of nematic and cholestric phases.

IV. Solid State : 06 Hrs

Types of solids, Amorphous, crystalline and difference between them, Miller Indices. Laws of crystallography - (i) Law of constancy of interfacial angels (ii)Law of rationality of indices (iii) Law of symmetry. Symmetry elements in crystals.X-ray diffraction by crystals.Derivation of Bragg equation.

V.Colloidal State : 03 Hrs

Definition of colloids, classification of colloids.

Solids in liquids (sols) : properties - kinetic, optical and electrical; stability of colloids, protective action. Hardy - Schulze Law. Liquids in liquids (emulsions) : types of emulsions, preparation. Liquids in Solids (gels) : classification, general applications of colloids.

Paper 202102 Inorganic Chemistry 2 Credits, 50 Marks(30 Hrs)

3Hrs / Week

I. Chemical Bonding: 12 Hrs

A) Covalent Bond - Valence theory and its limitations, various types of hybridization and shapes of simple inorganic molecules and ions, $BeCl_2$, BF_3, $SiCl_4$, PCl_5, SF_6, IF_7

Valence shell electron pair repulsion (VSEPR) theory for shapes of NH_3, H_2O, SF_4, ClF_3 and ICl_2^-

B) Ionic Bond : Formation of ionic bond, Lattice energy (Born Lande equation), Born Haber cycle, solvation energy (Numerical problems expected), solvation energy Fajan's rules

II.Chemistry of P block elements and noble gases : 10 Hrs

Comparative study of elements Gr.13 -17 elements : trends in periodic properties, allotropy, inert pair effect.

Chemical properties of the noble gases, chemistry of Xenon, structure and bonding in Xenon compounds.

III.Theory of Qualitative Analysis : 08 Hrs

Solubility product and common ion effect.Use of borax, cobalt nitrate,sodiumcarbonate,hydrogensulphide,ammonium chloride and yellow ammonium sulphide.

Detection of following acid radicals in presence of each other :CO_3^{-2} and SO_3^{-2}, NO_2^- and NO_3^- , Cl^-, Br^- and I^-

Paper 202201 Lab Course 2 Credits, 50Marks(30 Hrs)

2Hrs / Week

Unit 1 Physical Chemistry

I. Viscometer : To Determine Viscosity of given liquid (Water / Ethanol) by viscometer

II. Staglamometer : To determine surface tension of given liquid.

III. To determine percentage composition of BaSO4 + NH4Cl gravimetrically.

IV. To determine loss on drying (LOD) of detergent, salicylic acid.

Unit 2

Inorganic Qualitative Analysis :

Semimicro qualitative analysis : identification of two cations and two anions in the given mixture. (Complexities not expected) **Minimum 7 mixtures to be done.**

Cations :Pb^{2+} , Cu^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Mn^{2+}, Zn^{2+}, Ni^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+},Mg^{2+}, NH^{4+}, K^{+}

Anions :Cl^{-}, Br^{-}, I^{-}, SO_4^{2-}, NO_3^{-}, NO_2^{-} , CO_3^{2-}

Second Year - Third Semester

Paper 302101 Organic Chemistry 3 Credits, 75 Marks(45hrs)

		3hrs / week
I	Alcohols	06hrs
II	Phenols	06hrs
III	Aldehydes and ketones	10hrs
IV	Carboxylic Acids	09hrs
V	Organic compounds of Nitrogen	14hrs

Paper 302102 Physical Chemistry 3Credits, 75 Marks(45hrs)

		3hrs/week
I	Thermodynamics – I	15hrs
II	Thermodynamics – II	20hrs
III	Chemical Equilibrium	10hrs

Paper 302201 Lab course Organic & Physical
3 Credits,75 Marks(45hrs) 3hrs/week

Second Year - Fourth Semester

Paper 402101 Inorganic Chemistry 3Credits, 75 Marks(45hrs)

3hrs/week

I	Molecular Orbital Theory(MOT)	10 hrs
II	Chemistry of Transition elements	05hrs
III	Coordination of compounds	15hrs
IV	Gravimetric Analysis	10 hrs
V	Acids and Bases	05hrs

Paper 402102 Physical chemistry II 3Credits, 75 Marks(45hrs)

3hrs/week

I	Phase Equilibrium	15hrs
II	Electro –Chemistry I	15hrs
III	Electro –Chemistry II	15hrs

Paper 402201 Lab Course Inorganic & Physical

3 Credits, 75 Marks(45hrs) 3hrs/week

SECOND AND THIRD YEAR BSc Chem.

Third / Fourth / Fifth / Sixth Semester

Question Paper Pattern
for Theory

Time : 3 Hrs Maximum Marks : 75

Note: All Questions are Compulsory

Q.1	Attempt any FIVE of the following [(i) to (x)]	--- 15 Marks
Q.2	Attempt any THREE of the following [(i) to (v)]	--- 15 Marks
Q.3	Attempt any THREE of the following [(i) to (v)]	--- 15 Marks
Q.4	Attempt any THREE of the following [(i) to (v)]	--- 15 Marks
Q.5	Attempt any THREE of the following [(i) to (v)]	--- 15 Marks

SECOND AND THIRD YEAR BSc Chem.

Third / Fourth / Fifth / Sixth Semester

Question Paper Pattern for Practical

Lab Course I **Time :7Hrs**

Marks: 75

Q.1	Unit-I	--- 30 Marks
Q.2	Unit-II	--- 30 Marks
Q.3	Record Book and Viva Voice	--- 15 Marks

Second Year-Third Semester

Paper 302101 Organic Chemistry 3 Credits, 75Marks(45 Hrs)

3 Hrs/week

I)Alcohols : 06 Hrs

Definition: Monohydric Alcohols: Methods of formation by reductions of Aldehydes, Ketones, Carboxylic Acids and Esters (one eg.each) Acidic nature reaction of Alcohols. Dihydric Alcohols: Methods of formation of ethylene Glycol-industrial method and From Alkenes using OsO_4, Chemical reaction of ethylene Glycol-nitration, Acylation, Oxidation (Using $Pb(OAc)_4$ without Mechanism Pinacol-Pinacolone rearrangement,
Trihydric Alcohols: Preparation of Glycerol from propane, Reaction of Glycerol.

II)Phenols: 06 Hrs

Preparation of phenols from Chlorobenzene, Cumene and Benzene Sulphonic Acid, Physical properties, Acidic Nature of phenol, Resonance stabilization of Phenoxide Ion. Reaction of phenols-Electrophilic Aromatic Substitution, Acylation, Carboxylation (Without Mechanism) Reaction with Mechanism- fries rearrangement, Claisen Rearrangement, Gatterman Synthesis and Reimer Tiemann Reaction.

III)Aldehydes and Ketones: 10 Hrs

Aldehydes: Preparation of aldehyde from Acid Chloride, Gattermann-Koch synthesis Ketones- Preparation of nitriles and form Carboxylic Acid , Physical properties of Aldehydes and Ketones. Mechanism of Nucleophilic addition to Carbonyl Group with particular emphasis on Benzoin, AldolKnoenenagel condensation, Mannich Reaction. Use of Acetals as Protecting Groups.Oxidation of aldehydes using Chromium Trioxide, Baeyers-Villeger Oxidation of Ketones.

IV)Carboxylic Acids: 09 Hrs.

Acidity of Carboxylic Acids, Effect of substituents on acid strength, preparation of acetic acid from CO2 from nitriles, from acid chloride, Anhydride, Ester and Amide.
Physical properties and reaction of carboxylic acid-synthesis of Acid Chloride, Ester and Amide, Hell-Volhard-Zelinsky Reaction.Reduction using LiAlH4, Mechanism of Decarboxylation, Hydroxyl Acids- Malic, Tartaric and Citric Acid. Method of Formation and Chemical reaction of Acrylic Acid

V) Organic Compounds of Nitrogen: 14 Hrs

Preparation of Nitroalkanes and Nitroarenes.
Chemical reation of Nitroalkanes, Nitration of Benzene and their reduction in Acidic, Basic and Neutral media.
Amines – Basicity of Amines, Amines Salt as PTC. Preparation of alkyl and Aryl Amines (Reduction of Nitro Compounds, Nitriles) Reductive Amination, Hoffmann Bromamide Reaction.
Reaction of Amines- Electrophilic aromatic Substitution in Aryl amines, Reaction of amines with Nitrous Acids.

Paper 302102 Physical Chemistry 3 Credits, 75Marks(45 Hrs)

3 Hrs/Week

I)Thermodynamics: I 15Hrs

Definition of Thermodynamic Terms: System, Surrounding types of systems, intensive and extensive properties. Thermodynamic process, concept of heat ad work. Work done in reversible and irreversible process, concept of maximum work (Wmax), Numerical problems.
First law of thermodynamics: Statement, Definition of internal energy and Enthalpy. Heat capacity,heat capacities at constant volumepressure and their relationship. Calculation of W, q, du and dH for the expansion ideal gas under isothermal and adiabatic conditions for reversible process, Numerical problems, Hess's law of heat Summation and its application.

II)Thermodynamics: II 20Hrs

Second law of thermodynamics: Need for law, different statement of law.
Carnot Cycle and its efficiency, Numerical Problems.Carnot Theorem.
Concept of Entropy: Definition, Physical significance, entropy as a State Function, Entropy change in physical change, Entropy as criteria of Spontaneity & Equilibrium Entropy change in ideal gases. Gibbs and Helmholtz Function: Gibbs Function (G) and Helmholtz Function(A) as Thermodynamic Quantities. A and G as criteria for Thermodynamic Equilibrium and spontaneity, their Advantages over Entropy change. Variation A with P, V and T

III)Chemical Equilibrium: 10Hrs

Equilibrium Constant and Free Energy. Thermodynamics Derivation of law of Mass Action.LeChatliers's Principle.Reaction Isotherm and Reaction IsoCore.Clapeyron Equation, Clausius- Clapeyron Equation and its Application.

Paper 302201 Lab Course 3 Credits,75 Marks(45hrs) 3hrs/week

Unit 1 Organic Chemistry

Organic derivatives: Preparation,crystallization and physical constant:-

I)Acetyl derivative of aniline

II) Nitro derivative of Salicylic acid

III)Hydrolysis derivative of ethyl benzoate

IV) Bromoderivative ofcinnamic acid

V) 2-4 DinitrophenylHydrazone derivative of acetone

Unit 2 Physical Chemistry

I) To determine heat of neutralization (ΔHn) of NaOH and HCl.

II) To determine the equilibrium constant for the reaction : KI + I2 -------- KI3

III) Determine molecular mass of the polymer Polyvinyl Alcohol(PVA) from viscosity measurement.

IV) To investigate the reaction between potassium persulphate and KI of equimolarconcentration (a=b)

V)Chemical Kinetics : To determine the specific reaction rate of the hydrolysis of methyl acetate catalysed by hydrogen ions at room temperature.

Second Year –Fourth Semester

Paper 402101 Inorganic Chemistry 3 Credits, 75Marks(45 Hrs)

3 Hrs/Week

I) Molecular Orbital Theory(MOT) : 10 Hrs

Conditions for the formation of Molecular Orbitals

Linear combination of Atomic Orbitals method to obtain Molecular Orbitals.

(LCAO- MO) approach, Application of (LCAO- MO) approach to the formation of :

Homonucleardiatomic molecules : H_2, He_2, N_2, O_2, F_2, Ne_2

Calculation of Bond Order and correlation with stability ,bond length and bond energy and magnetic properties of all the molecules mentioned.

Bond order in O_2,O_2^+ ,O_2^- ,O_2^{-2}

Heteronucleardiatomic molecules and molecular ion: CO, NO, CN^-

MO diagrams with explanation of bond order, stability, and magnetic behaviour.

II) Chemistry of Transition Elements: 5 Hrs

Definition and general characteristics of transition element.

Chemistry of transition elements (3d) with reference to : electronic configuration , atomic size, ionization potential, oxidation states , colour and magnetic property , formation of coordination compounds and applications.

III) Coordination Compounds 15Hrs

Distinction between double salts and coordination compounds

Werner's theory and its experimental verification

Effective Atomic Number (EAN) rule

IUPAC nomenclature

Isomerism in coordination compounds:

Structural : Ionization,Hydrate,Linkage and coordination position isomerism

Stereoisomerism: geometrical and optical isomerism with reference to coordination number 4 and 5

Bonding in Coordination Compounds based on Valence Bond theory (VBT)

Application to 4,5,6 coordinate complex

Electroneutrality principle and Back bonding

IV) Gravimetric Analysis : 10 Hrs

Definition and types of Gravimetric analysis

Precipitation Gravimetry

Solubility considerations : Common ion effect, diverse ion effect, pH, temperature and nature of solubility,Controlling particle size

Treatment of precipitates in gravimetry :

Digestion, Filtration and Washing, Drying and ignition

Use of Organic Reagents in Gravimetric Analysis

V) Acid Base concepts : 05Hrs

Different classifications of acids and bases such as Arrhenius, Bronsted –Lowry Lewis , Solvent system and Lux Flood concepts

Pearson's Hard Soft Acid Base (HSAB) principle

Paper 402102 Physical Chemistry 3 Credits, 75Marks(45 Hrs)

3 Hrs/Week

I) Phase Equilibrium: 15 Hrs

Statement and Meaning of the terms:Phase,Component,Degree of freedom,Derivation of phase rule equation.

Phase Equilibria of the one component system:Water system.

Phase Equilibria of two components system:solid-liquidequilibria, simple eutectic Pb-Ag system, desilverisation of lead.

Solid solutions : compound formation with congruent melting point (Mg-Zn) and incongruent melting point ($FeCl_3$ –H_2O)system, freezing mixture, acetone-dry ice, liquid-liquid mixture, Raoult's law and Henry's law.

Ideal and non-ideal system :azotropes, HCl-H2O and ethanol – water system. Partially miscible liquids:phenol-water,trimethyl amine-water, nicotine-water system,lower and upper consulate temperature. Effect of impurity on consulate temperature

II) Electro chemistry-I 15 Hrs

Electrical Transport:Conduction in metals and in electrolytesolutions : specific conductance and equivalent conductance,measurement of equivalent conduction,variation of equivalent and specific conductance with dilution. Numerical problems.Kohlrausch's law and its application weak and strong electrolytes,Ostwald'sdilution law ,its use and limitations. Transportnumber:Definition,Determination by Hittorf's method and moving boundary method. Conductometric titration: types and its advantages.

III) Electrochemistry-II 15Hrs

Types of reversible electrodes:gas-metalion,metal-metal ion,metal-insoluble salt anion and redox electrodes. Nernst equation,derivation ofcell,E.M.F.and single electrode potential,standard hydrogen electrode,referenceelectrode,standard electrode

potential,signsconventions,electro-chemical series and its significance,electrolytic and galvanic cells,reversible and irreversible cells,conventionalrepresentation of electro chemical cells E.M.F.of a cell and its measurement,calculation of thermodynamic quantities of cell reactions (G,H and K).

Definition of pH,pKa-determination of pH using SHE and Glass electrode by potentiometer method. Buffer-Acidic and basic buffers,mechanism of Buffer Action,Henderson-Hasselbalch equation.

Paper 402201 Lab Course 3 Credits,75 Marks(45hrs) 3hrs/week

Unit 1 Inorganic

Gravimetric Estimation:

I) Estimation of Barium gravimetrically as Ba-Sulphate

II) Estimation of Ferrous gravimetrically as Fe_2O_3

III) Estimation of Zinc gravimetrically as Zinc Pyrophosphate (ZnP_2O_7)

IV) Estimation of Barium gravimetrically as Ba-Chromate ($BaCrO_4$)

V) Estimation of Nickel gravimetrically as Ni-DMG

Unit 2 Physical chemistry

I) To determine normality and strength of HCI using (0.1N) NaOH solution conductometrically.

II) To determine normality and strength of acetic acid using (0.1N)NaOH solution conductometrically

III) To determine normality and strength of acetic acid using (0.1N)NaOH solution by pH-metrically

IV) Potentiometric titration to find E^0cell, G andequilibrium constant

V) pH metric titration;Henderson's Equation

Third Year – Fifth Semester

Paper 502101 Physical Chemistry 3 Credits,75 Marks(45hrs)

		3hrs/week
I.	Elementary quantum mechanics	12hrs
II.	Spectroscopy	15hrs
III.	Photochemistry	08hrs
IV.	Physical properties and molecular structure	10hrs

Paper 502102 Organic Chemistry 3 Credits,75 Marks(45hrs)

	3hrs/week
I. Synthetic dyes and drugs	16hrs
II.Organometallic compounds	08hrs
III.Organic synthesis viaenolates	13hrs
IV.Fats,oils and detergents	08hrs

Paper 502103 Inorganic Chemistry 3 Credits,75 Marks(45hrs)

		3hrs/week
I.	Solid State Chemistry	10hrs
II.	Superconductivity	05hrs
III.	Chemistry of Lanthanides	10hrs
IV.	Chemistry of Actinides	05hrs
V.	Organometallic Chemistry	10 hrs

VI.	Chemistry of Non aqueous solvents	05hrs

Paper 502104 Analytical Chemistry 3 Credits,75 Marks(45hrs)

3hrs/week

I.	Introduction to Analytical Chemistry	07 Hrs
II.	UV-Vis Spectroscopy	08Hrs
III.	Titrimetric Methods	15Hrs
IV.	Methods of Separation	15Hrs

Paper 502201 Lab Course Physical& Organic chemistry
3 Credits,75 Marks(45hrs) 3 Hrs/Week

Paper 502202 Lab Course Inorganic &Analytical Chemistry
3 Credits,75 Marks(45hrs) 3 Hrs/Week

Third Year – Sixth Semester

Paper 602101 Physical Chemistry 3 Credits,75 Marks(45hrs)

3hrs/week

I.	Colligative properties of diluteSolutions	13hrs
II.	Nuclear chemistry	10hrs
III.	Renewable energy sources	07hrs
IV.	Surface chemistry	15hrs

Paper 602102 Organic chemistry 3 Credits,75 Marks(45hrs)

3hrs/week

I.	Heterocyclic compounds	13hrs
II.	Carbohydrates	10hrs
III.	Synthetic polymers	07hrs
IV.	Spectroscopy	15hrs

Paper 602103 Inorganic chemistry 3 Credits,75 Marks(45hrs)

3hrs/week

I.	Metal-ligand bonding in transition metal complexes	13hrs
II.	Electron spectra of transition metal complexes	07hrs
III.	Stability of complexes	05hrs
IV.	Substitution reaction of octahedral complexes	05hrs
V.	Bioinorganic chemistry	10hrs

VI. Catalysis by TM complexes 05hrs

Paper 602104 Analytical Chemistry 3 Credits,75 Marks(45hrs)

3hrs/week

I. Optical methods 15hrs

II. Methods of separation 15hrs

III. Miscellaneous methods 15hrs

Paper 602201 Lab Course Physical& Organic Chemistry
3Credits,75 Marks(45hrs) 3 Hrs/Week

Paper 602202 Lab Course Inorganic &Analytical Chemistry
3Credits,75 Marks(45hrs) 3 Hrs/Week

Third Year Fifth Semester

Paper 502101 Physical chemistry 3 Credits,75 Marks(45hrs)

3 Hrs/Week

I. Elementary quantum mechanics 12 Hrs

Black body radiation,Planck's radiation law,photoelectric effect,Bohr's modes of hydrogen atom (no derivation) and its defects.De Broglie Hypothesis,the Heisenberg's uncertainty principles,Harmiltonian operator,Schrodinger wave equation and its importance,physical interpretation of the wave function,postulates of quantum mechanics.Schrodinger wave equation for H-atom,separation into three equations(without derivation),quantum numbers and their importance.

II. Spectroscopy 15Hrs

Introduction-Electromagnetic radiation,regions of the spectrum,basic features of different spectrometers,statement of the born-oppenheimerapproximation. Vibrational spectrum, rotational spectrum-diatomic molecules,energy levels of a rigid rotor(semi classical principles),selection rule,rotational spectra of rigid diatomic molecule,determination of bond length,numerical problems.

III. Photochemistry 08hrs

Introduction of radiation with matter,differencebetween thermal and photochemical processes.Law of photochemistry, Grothus-Drapper law,Stark-Einstein law,Jablonsiki diagram qualitative description of fluorescene,phosphorescence,non-radiative processes (internal conversion, intersystem crossing),quantum yield,photosynthesitized reactions.

IV. Physical properties and molecular structure 10Hrs

Optical activity and its measurement,dipole movement and its measurement by temperature change method,magnetic property and its measurement by Guoy balance method,applications of optical activity,dipole movement and magnetic property for determination of structure of molecule

Paper 502102 Organic chemistry 3 Credits,75 Marks(45hrs)

3 Hrs/Week

I) Synthetic Dyes and Drugs 16 Hrs.

Definition, colour and constitution (electronic concept) of dye, classification based on chemical constitution, synthesis of methyl orange, Congo red, malachite green, crystal violet, Alizarin and indigo dyes. Synthetic Drugs, Definition, introduction, classification of drugs.Properties of ideal drug.Synthesis of chloromycetien, paracetamol,phenacetien, sulphaguainidine.

II. Organometallic compounds 08 Hrs

Organomagnesiumcompounds:the Grignard reagent formation,structure and chemical reactions.organozinccompound,formation and chemical reactions,organolithium compound, formation and chemical reactions

III. Organic synthesis via enolates 13Hrs

Definition,active methylene compounds,preparation of acetoacetic ester,(Claisen condensation withmechanism),acidity of alpha hydrogen, properties and reactions involving formation ofmono,di and unsaturated carboxylic acids,synthesis of ketone,di-ketone,4-methyluracil from acetoacetic ester,keto-enoltautomerism. Preparation of diethyl malonate,properties and reactions involved in alkylation,formation of mono,di and unsaturated carboxylic acids,synthesis of glycine and barbutric acids from diethyl malonate.

IV. Fats,oils and detergents 08Hrs

Natural fats,edible and industrial oils of vegetable origin,manufacture of soyabean oil by solvent extraction method and isolation and uses of essential oils. Types of animal fats and oils and definition of saponification value, iodine value and acid value.Detergents:definition, introduction and preparation of sodium alkyl sulphonate,alkyl benzene sulphonate,and amide sulphonate,(one example each),cleansing action of detergent.

Paper 502103 Inorganic Chemistry 3 Credits,75 Marks(45hrs)

3 Hrs/Week

I. Solid state chemistry 10hrs

Classification of solids on the basis of bonding
Explanation of terms : crystal lattice, lattice points, unit cell, lattice constants, Closest packing of rigid spheres (hcp, ccp) Packing density in simple cubic,bcc,fcc andhcplattices (numerical problems expected)Tetrahedral and octahedral voids, radius ratio, limiting radius ratios and their significance . Calculation of limiting radius ratio for coordination number 3 and 4Structure of sodium chloride , cesium chloride and zinc sulphide

II. Superconductivity 5hrs

Introduction, critical temperature, Meissner effect
Different types of superconducting materials : conventional, organic, alkali metal fullerides and high temperature superconductors, applications.

III. Chemistry of Lanthanides 10hrs

Chemistry of Lanthanides with reference to I) oxidation states, ii) magnetic properties, iii) colour and absorption spectra,iv) complex formation, v) lanthanide contraction
Occurrence, extraction and separation of lanthanides by i) ion exchange ii) solvent extraction method.Applications of lanthanides

IV. Chemistry of Actinides 5hrs

Chemistry of Uranium and Plutonium with reference to occurrence, extraction (solvent extraction method) properties and applications.
Comparative chemistry of Lanthanides and Actinides.

V. Organometallic Chemistry 10hrs

Introduction, definition, classification on the basis of Hapticity and Nature of metal carbon bond.Preparation, properties and applications of alkyls and aryls of Li, Al, Hg, Sn
Classification, preparation, properties and bonding in Metal carbonyls.
Eighteen electron rule applicationsand exceptions.

VI. Chemistry of Non aqueous solvents 05hrs

Classification of solvents and importance of Non aqueous solvents.
Reactions in Non aqueous solvents with reference to liquid ammonia and liquid SO_2 as solvents.

Paper 502104 Analytical Chemistry 3Credits,75 Marks(45hrs)

3 Hrs/Week

I. Introduction to analytical chemistry : 7hrs

Analytical chemistry qualitative and quantitative analysis, classification of analytical methods with emphasis on detection limit and sensitivity.

Steps involved in chemical analysis: sampling, obtaining a sample, processing the sample, selection of a method for analysis, calibration and actual analysis, data collection, data processing, presentation of results and interpretation.

Performance characteristics of an analytical method : accuracy, precision, detection limit, dynamic range, sensitivity, selectivity.

Quantitative analysis with calibration curve and standard addition method.
Applications of analytical methods in various fields such as organic,pharmaceuticals, electronic and environmental analysis.

II. UV- Visible Spectroscopy : 8 hrs

U. V. and visible spectroscopy, absorption spectroscopy, terms involved : radiant power, absorbance, transmittance, percentage transmittance, wavelength of maximum absorption.

Statement of the Beer's law and the Lambert's law, [derivation expected] combined expression, molar extinction coefficient, deviations from the Beer – Lambert's law, limitations.

Components of an optical instrument,photometers and spectrophotometers, construction of a single beam photometer.

III. Titrimetric methods: 15hrs

Introduction to titrimetric methods of analysis
Terms : titration, titrand, titrant, titre value, indicator, endpoint, equivalence point**,**

Classification of titrimetric analysis

Acid – base titration:

construction of titration curves and choice of indicator/s in the titration of [1] strong acid and strong base, [2] strong acid and weak base, [3] weak acid and strong base, [4] weak acid and weak base.

Precipitation titrations:Argentimetric titrations, construction of the titration curves, Volhard's method, Mohr's method, adsorption indicators.

Complexometric titrations: general introduction, EDTA titrations, advantages and limitations of EDTA as the titrant, complexesmetallochromic indicators

Redox titrations: general introduction, theory of redox indicators, criterion for choosing an indicator for a redox titration, construction of the titration curves in the case of (1) Fe(II) Vs. Ce(IV), (2) Fe(II) Vs. dichromate, use of diphenyl amine and ferroin as redox indicators.

Non aqueous titrations: need for nonaqueous titrations, types of solvents, solvents used

Use of instrumental methods in titrimetric analysis :

Conductometric titrations : basic principles, experimental set up, titration curves in the titration of i] strong acid vs. strong base, ii] weak acid vs. strong base, iii] weak acid vs. weak base, iv] Mixture of strong and weak acid/ strong and weak base vs. strong base/ weak base or strong acid / weak acid. v] sodium chloride vs. silver nitrate vi] barium hydroxide vs. magnesium sulphate advantages and limitations.

Potentiometric titrations : basic principles, concept of indicator electrode, indicator electrodes for different types of titrations, determination of end point from the graphs of E vs. V, $\Delta E/\Delta V$ vs. mean volume, Δ^2E/Δ^2V vs. mean volume, advantages and limitations.

IV. Methods of Separation : 15Hrs

Solvent extraction: partition coefficient and distribution ratio, extraction efficiency, separation factor, role of complexing agents in solvent extraction, chelation, ion pair formation, salvation, types of solvent extraction: batch, continuous.

Chromatography: introduction to chromatographic techniques, classification of chromatographic techniques.

Planar chromatography: principle, techniques and applications of

Paper chromatography [2] Thin layer chromatography and

Electro- chromatography: electrophoresis, slab electrophoresis,

Size exclusion chromatography: Principle and applications.

Paper 502201 Lab Course 3 Credits,75 Marks(45hrs)

(3hrs/week)

Unit 1 Physical Chemistry

I. To determine the energy of activation for the acid catalysed hydrolysis of methyl acetate.

II. To determine the strength of given strong acid (HCl) by potentiometric titration using quinhydrone electrode (calculation of pH from E and the plot of $\Delta E/\Delta V$ against V and pH.

III To determine acidic and basic dissociation constant of amino acid hence to calculate isoelectric point

IV To investigate the Kinetics of Iodination of acetone.

V. To determine the amount of Fe(II) in the given solution by titration with standard $K_2Cr_2O_7$ solution to find the formal redox potential of Fe+.

Unit2 Organic Chemistry

Binary Mixture : Separation and identification of both components (any six mixtures covering each chemical type).

I Benzoic Acid + β-napthol

II Salicylic Acid + m-nitro aniline

III β-napthol + acetanilide

IV Oxallic Acid + Naphthalene

V β-naphthol + p-nitroaniline

VI Cinnamic Acid + Naphthalene

VII β-napthol + m-dinitrobenzene

VIII Cinnamic Acid + P- nitro aniline

IX Salicylic Acid + β-napthol

Paper 502202 **Lab Course** **3 Credits,75 Marks(45hrs)**

3hrs/week

Unit 1 Inorganic Chemistry

Complexometric Titration:

i) To estimate amount of Copper ions in the given solution of Copper sulphate Iodometrically.

ii) To estimate amount of Zinc ions in the given solution by EDTA solution using EBT indicator.

iii) To estimate amount of Nickel in the given solution by EDTA solution using Murexide indicator.

iv) Estimation of Lead by EDTA solution using Xylenol Orange indicator

v) Estimation of Hardness of water sample

Unit 2 Analytical Chemistry

I To verify Lambert-Beers Law using Methyl Orange.

II Estimate COD of given water sample.

III To determine the amount of K by flame photometry, calibration curve method.

IV Estimation of glucose in Honey by Willstatter method.

V Estimation of vitamin C in lemon juice.

Third Year Sixth Semester

Paper602101 Physical Chemistry 3Credits,75 Marks(45hrs)

3 Hrs/ week

I) Colligative properties of Dilute Solutions 13 hrs

Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure. Elevation in boiling point of a solution, thermodynamic derivation relating elevationin the boiling point of a solution and the molar mass of a non volatile solute.Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point a solution and the molar mass of a non volatile solute.Osmotic pressure, van'thoff's equation for osmotic pressure (derivation is expected) and determination of molar mass of the solute abnormal molar masses of solutes and van't Hoff factor (calculation of degree of association and degree of dissociation)

II) Nuclear Chemistry 10 hrs

Type of nuclear radiations and their characteristics, behaviour of ion-pairs electric field, detection and measurement of nuclear radiations using G.M. counter and scintillation counter.Kinetics of radioactive decay, units of radioactivity (Curie, becquree, Rutherford).Radioactive equilibrium (secular and transient) determination of radioactive consents for radio-elements having 1) moderate half life, 2) long life, 3) extremely long or short half life.Use of radioisotopes as tracers in, 1) chemical investigations reaction mechanism, 2) age determination – dating by tritium content and by carbon -14.

Nuclear Reaction – nuclear transmutation, artificial radioactivity (suitable examples using different projectiles are expected) Q-value of nuclear reactions, threshold energy. Fissile and fertile material, nuclear fission, chain, reaction, factors controlling fission process(multiplication factor and critical size or mass of fissionable material) nuclear reactor and breeder reactor. Nuclear fusion, characteristics of nuclear fusion, thermonuclear occurring ins stellar bodies.

III) Renewable Energy Sources 07 hrs

Batteries – Secondary cells lithium ion cell.

Fuel Cells – Choice of fuel and oxidant, thermodynamic and kinetic aspect of electrochemical energy transformation, efficiency of fuel, cells, bacon'H2 and O2 fuel cell.

Solar cells, solar energy, photovoltaic effect, semiconductor, as solar energy converters, silicon solar cell.

Biomass energy : biomass and its sources, conversion on biomass into energy by alcohol fermentation and anaerobic digestion method.

Hydrogen : Fuel of the future, production of hydrogen by direct electrolysis of water and biomass gasification, advantage of hydrogen energy medium.

IV) Surface chemistry 15 hrs

Adsorption, physical and chemical adsorption, types of adsorption isotherms, Langumir's adsorption isotherm, (Postulates and derivation expected) B.E.T. equation for multilayer adsorption equation is expected) determination of surface area of and adsorbent using B.E.T. equation.

Paper 602102 Organic Chemistry 3Credits,75 Marks(45hrs)

3 Hrs /week

I) Heterocyclic Compounds 13 Hrs.

Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine.Comparison of basicity of pyridine, piperidine and pyrrole.Condensed Heterocyles: Introduction, Preparation of Quinoline (Skraups Synthesis), Isoquinoline (Bischler - Napirlaski) and Indole (Fischer indole Synthesis).

II) Carbohydrates 10 Hrs.

Definition, Introduction and Classification.Monosaccharides-Interconversion of Glucose and Fructose, chain lengthening, chain shortening of aldoses.Conversion of Glucose in to mannose.Determination of ring size of Monosaccharide, Mechanism of Mutarotation and Introduction to disaccharides (maltose, sucrose and lactose) and Polysaccharides (Starch and cellulose) without involving structure determination.

III) Synthetic Polymers 07 Hrs.

Introduction, Classification based on nature of synthesis (without mechanism) with examples. (Addition and condensation polymers).Properties, uses and synthesis of polyvinyl chloride, polyvinyl acetate, polystyrene, polyacrylonitrile, Nylon 6, Nylon 66.Introduction to synthetic and natural rubber, properties, uses and synthesis of Buna N., Neoprene and silicon rubber.

IV. Spectroscopy 15Hrs

UV-visible spectroscopy : Introduction, electronic transitions and designation of UV absorption bands, general applications of UV spectroscopy. Definition of Chromophores, Auxochromes, red and blue shifts.Identification of Isolated double bond, conjugated dienes, polyenes.Woodward-Feiserrules for dienes and trienes, Feiser-Kuhn rules for polyenes, Woodward rule for α, β unsaturated aldehydes and ketones.

Infrared spectroscopy :Introduction, absorption in the IR region, presentation of IR spectra, Molecular vibrations, calculation of vibrational frequencies (Hooke's Law).Application of IR spectroscopy, interpretation of IR spectra, characterisation of functional groups.

Paper 602103 Inorganic Chemistry 3Credits,75 Marks(45hrs)

3 Hrs /week

I) Metal ligand bonding In TM complexes : 13Hrs

Crystal Field Theory (CFT)applied to coordination compounds
Assumptions of CFT, splitting of d orbitals in octahedral,tetrahedral and square planar complexes
Factors affecting the magnitude of 10 Dq / high and low spin complexes
Crystal field Stabilization energy (CFSE), calculation of CFSE for octahedral and tetrahedral complexes,Effect of crystal field splitting on ionic radii and lattice energy
Theoretical failure of CFT.

II) Electronic Spectra of TM complexes : 7Hrs

Types of electronic transitions like d-d, charge transfer, intra ligand
Rules for electronic transitions Laporte and Spin selection rule
Orgel diagram for d^1, d^4, d^6, d^9 metal ion
Electronic spectra of $[Ti(H_2O)_6]^{+3}$ complex ion
Application of electronic spectra.

III) Stability of complexes: 5Hrs

Thermodynamic and Kinetic stability of complexes
Stepwise and overall stability constants and their inter-relationship
Factors affecting thermodynamic stability, Chelate effect

IV) Substitution reactions of octahedral complexes 5Hrs

Introduction, types of reactions in complexes
Ligand substitution reactions:Basic Mechanisms
Labile and Inert complexes, Electronic configuration and lability of complex
Mechanism for acid and base hydrolysis of cobalt ammine complexes.

V) Bioinorganic Chemistry 10Hrs

Introduction, essential and nonessential elements,
Biological role of alkali metals (Na, K) and alkaline earth
Metalloporhyrinswith special reference to Haemoglobin, Myoglobin,Chlorophyll.

VI) Catalysis by Transition Metal complexes 5Hrs

IntroductionCatalysis with reference to i) hydrogenation of alkenes (Wilkinson catalyst) , ii) Hydroformylation reaction (Roolen catalyst) iii) polymerization of alkenes(Ziegler-Natta catalyst)

Paper 602104 Analytical Chemistry 3Credits,75 Marks(45hrs)

3 Hrs /week

I) Optical methods 15Hrs

Atomic spectroscopy: Absorption and emission spectra, energy level diagrams, processes involved in atomization, flame photometry, flame atomizer, types of burners,

monochromatorsand detectors, atomic absorption spectroscopy: flame and electrothermal atomizer, sources, instrumentation, quantitative applications of atomic absorption and flame photometery, calibration curve method, standard addition method and internal standard method.
Molecular fluorescence and phosphorescence spectroscopy: theory, instrumentation and applications.
Infrared spectroscopy**:** sources, sample handling, detectors.

II) Methods of Separation 15Hrs

Gas chromatography**:** gas liquid chromatography, basic principles, retention time, retention volume, resolution, peak width, theoretical plates, HEPT, instrumentation, columns, detectors, applications.
High performance liquid chromatography: instrumentation, types of elution, U.V. and R. I. Detector and applications.

Ion exchange chromatography: types of ion exchangers, mechanism of ion exchange, selectivity coefficients and separation factors, capacity and its determination, factors affecting the separation of ions, applications.

III) Miscellaneous Methods 15Hrs
Quality:Concept of quality, quality control, quality assurance, total quality management, ISO series, Good Laboratory practices.

Turbidimetry and Nephelometry: scattering of light, effect of concentration, particle size and wavelength on light scattering, instrumentation and applications.
Mass spectrometry: basic principles, introduction of components only.
Introduction to radio analytical techniques: classification of the techniques, introduction o neutron activation analysis and its applications.
Thermal methods, classification of thermal methods, thermo gravimetric analysis basic principles, instrumentation factors affecting the TG curve, applications.

Paper602201 Lab Course 3 Credits,75 Marks(45hrs)

3hrs/week

Unit I Physical Chemistry

1. To determine the amount of Fe(III) present in the given solution using salicylic acid by colorimetric titration.
2. To determine the order of reaction between $K_2S_2O_8$ and KI by fractional change method.
3. To determine empirical formula of Ferric -5-sulphosalicylate
4. Determine the amount of Fe^{2+} in the given solution potentiometrically
5. To determine the refractive indices of series of salt solutions and to find out concentration of the salt in given unknown solution.

Unit 2 Organic Chemistry

1.Estimation of nitro group by reduction
2.Estimation of amides by hydrolysis
3.Estimation of Saponification value of oil
4.Estimation of Iodine value of oil
5. Estimation of Aldehyde content of oil

Paper 602202 Lab Course 3 Credits,75 Marks(45hrs)

3hrs/week

Unit I Inorganic Chemistry

I)To prepare tetramineCopper(II) sulphate
II) To prepare bis(ethylene diamine) Copper(II) sulphate
III) To prepare tris(ethylenediamine) Nickel(II) thiosulphate
IV) To prepare tris(acetylacetonato) Iron(III)
V) To Prepare bis(8-hydroxy quinolinato) Magnesium(II)

Unit 2 Analytical Chemistry

I) Estimation of Saline from Dextrose Saline by Mohr's Method
II) Estimation of magnesium in talcum powder
III) Estimation of phosphoric acid in Cola sample pH-metrically
IV) Percentage purity of sodium chloride using cation exchange resin.
V) Fluoride content by colorimetry in NaF.

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1.Advanced Physical Chemistry, Snehi&Gurthu
2. Physical Chemistry, Atkins
3.Electrochemistry, S.Glasstone
4.Chemical Kinetics, K.J.Laidler
5.Quantum Chemistry, L.Prasad
6. Essentials of Nuclear Chemistry, H.J. ArnikarIVth edition Wiley Eastern
7. Introduction of Nuclear and Radio chemistry, G. Friedlander, T. W. Kennedy, E.S. Macias &J.M.MillerIIIrd Edition John Wiley
8. Experiments in Physical Chemistry, J.M.Newcombe. R.J.Denaro, A.R. Rickett, R.M. Wilson, Pergamon
9. Findlay's Practical Physical Chemistry, B.P. Levitt and J.A. Kitchener, 9th Edition, Longmans

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17. Photochemistry, C. E. Wayne and R. P. Wayne, Oxford University Press, New Delhi, Indian Edition. 2005.
18.Hetrocyclic Chemistry, J. A. Joule and K. Mills, 4th Edition, Wiley India Pvt. Ltd. New Delhi, 2008.
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20.PolymerScience, V. K. Ahluwalia and A. Mishra, Ane Books Pvt. Ltd., New Delhi, 2009.
21. An introduction to Green Chemistry, V. K. Ahluvalia, Vishal Publishing Co.

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3 rdedition,John Wiley and Sons.
2. Concise Inorganic Chemistry, J.D. Lee 4thedition,ELBS.
3. Inorganic Chemistry,D.F.Shriver and P.W.Atkins 3 rdedition, OxfordUniversityPress
4.Inorganic Chemistry : Principles of Structure and Reactivity, J.Huheey, E.A.Keiterand, R.L. Keiter, 3rdedition, Addison-Wiley Publishing Co.
5. Concepts and Models of Inorganic Chemistry, B.E.Douglas and D.H Mc Daniel, oxford press
6. Advanced Inorganic Chemistry, Gurdeep Raj, Goell publishing house
7. Modern Inorganic Chemistry, R.D Madan, S.Chand& Co
8. Advanced Inorganic Chemistry, Satyaprakash, Tuli
9. Organometallic Chemistry: An Unified Approach,R.CMehrotra and A.Singh, 2nd edition
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12.Vogel's Textbook of Qualitative Analysis
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