

BANGALORE



UNIVERSITY

B. Sc., Chemistry Syllabus

**I to VI Semesters
(w. e. f. 2014)**

**Department of Chemistry
Central College Campus
Bangalore - 560 001**

FOREWORD

As per the directive from the Bangalore University, the Chemistry syllabus for the B. Sc., degree course (CBCS) had to be prepared. Guidelines for this were provided by the University.

In the Department of Studies in Chemistry, Central College, with the help of the Chemistry Teachers' Forum, a Core Group involving the Teachers of the University Department and affiliated colleges was constituted. This Core Group participated in work-shops held on 22.04.2014, 30.04.2014 and 19.05.2014, keeping in view the aims of the UGC Model Curriculum in developing interdisciplinary skills in students linking general studies with professional courses and allowing both vertical and horizontal mobility and also catering to local needs the syllabus was prepared.

Teachers of different branches of Chemistry, namely Inorganic, Organic, Physical and Biochemistry had separate and joint brainstorming sessions and arrived at a Draft Syllabus in Chemistry for SIX semesters. The Chemistry Teachers' Forum played a pivotal role during the drafting of the syllabus. The Draft Syllabus in chemistry was brought to the attention of a wider group of Teachers for further refinement on 23th May 2014. The final draft incorporating the suggestions was placed before the Department Council on 02. 6. 2014 and then the Board of Studies in Chemistry (UG) on 07. 6. 2014 for approval.

CHAIRMAN

Department of Studies in Chemistry
Central College Campus
Bangalore University
Bangalore-560 001

**Members of the Committee for the Preparation of the Chemistry Syllabus for the
B. Sc., Degree Course (Semester Scheme)**

Chemistry Teachers' Forum: Bangalore University, Bangalore

Physical Chemistry Section

Dr. Girija C R	SSMRV College, Bangalore
Mr. Sripathi	Vivekananda College, Bangalore
Dr. Vasundara D E	BMS College, Bangalore
Ms. Malathi M	Rural College , Kanakapura
Mr. S. Uday Kumar	Rural College, Kanakapura

Inorganic Chemistry Section

Mr. H B Mallesh	GFGC, Channapatna
Mr. Vijaya Babu B.	GFGC, Vijayanagar
Mr. Ramanna	Kongadiappa College, Doddaballapura
Dr. Muddu Krishna K R.	Govt. First Grade College, Varthur, Bangalore
Ms. Hamsini S	GFGC Chickaballapur.
Ms. Vanitha G K	GFGC, Doddaballapur
Mr. G R Rangappa	GFGC, Kolar
C Sanjeevarayappa	GFGC, Yelahanka

Organic Chemistry Section

Dr. Shylaja S	GFGC, K R Puram, Bangalore
Dr. Rekha S	VVS First Grade College, Bangalore
Dr. Shashikala Devi K	Maharani Science College, Bangalore
Dr. Prathima Rao	Vivekananda College, Bangalore
Ms. Shamsiya Rizwana	M E S College, Bangalore
Mr. Sridhar B T	Maharani Science College, Bangalore

Biochemistry Section

Dr. Nanda N	BMS College for Women, Bangalore
Ms. Radhika R	GFGC, Channapatna
Ms. Kathyayini	National College, Gowribidanur.

Proceedings of the Meeting of Board of Studies in Chemistry (UG) held on 7th June 2014 at 10.30 am in the Department of Chemistry, Central College Campus, Bangalore-560 001.

The Chairman welcomed the members of the Board to the meeting and placed the agenda before them for discussion.

Agenda: 1. *Scrutiny and approval of the Syllabus for the B. Sc., Degree, Chemistry Course (Semester Scheme).*

2. *Preparation of the BOE (UG) and Professional Courses for the Academic Year 2014-15.*

The Chairman informed the members that, as per the directive from the Bangalore University, the Chemistry syllabus for the B. Sc., degree has been prepared with the help of the Chemistry Teachers' Forum which constituted a Core Group from affiliated Colleges, is proposed to be introduced from 2014 onwards. In this connection, the Core Group participated in workshops held on three days: 22. 04. 2014, 30. 04. 2014 and 19. 05. 2014 and prepared a Draft syllabus. The syllabus was then finalized in a workshop conducted on 23th May 2014 in the presence of a wider group of Teachers represented by most of the colleges offering Chemistry at UG level. The draft syllabus was then placed before the Department Council on 2. 6. 2014 for approval, the approved syllabus is now placed before the Board for Scrutiny and approval.

The Board of Studies (UG) approved the Syllabus after some modifications.

The Board also prepared the BOE (UG) Chemistry and BOE Professional Course (BE., Chemistry).

The meeting ended with the vote of thanks by the Chairman.

The following members were present.

1. Dr. Shaheen Taj
2. Sri. R. Vinay Kumar
3. Sri. S. Vijay Kumar
4. Sri. H. B. Mallesh
5. Sri. G. Siddalingaiah
6. Smt. M. Malathi
7. Dr. Venkatesha, B. M (External Member)
8. Dr. Nanjundaswamy, N (External Member)
9. Dr. M. A. Pasha Chairman, (BOS, UG)

SCHEME OF EXAMINATION

Title of the paper	Contact hours/Week	Exam. hours	IA	Marks	Total Marks	Credits
First Semester						
Chemistry-I	4	3	30	70	100	2
Chemistry Practical-I	3	3	15	35	50	1
Second Semester						
Chemistry-II	4	3	30	70	100	2
Chemistry Practical-II	3	3	15	35	50	1
Third Semester						
Chemistry-III	4	3	30	70	100	2
Chemistry Practical-III	3	3	15	35	50	1
Fourth Semester						
Chemistry-IV	4	3	30	70	100	2
Chemistry Practical-IV	3	3	15	35	50	1
Fifth Semester						
Chemistry-V	3	3	30	70	100	2
Chemistry- VI	3	3	30	70	100	2
Chemistry Practical-V	3	3	15	35	50	1
Chemistry Practical-VI	3	3	15	35	50	1
Sixth Semester						
Chemistry-VII	3	3	30	70	100	2
Chemistry VIII	3	3	30	70	100	2
Chemistry Practical-VII	3	3	15	35	50	1
Chemistry Practical-VIII	3	3	15	35	50	1

**B. Sc., – I Semester
Paper- I**

UNIT-I

Mathematical Concepts for Chemistry

4 hours

Logarithmic relations: Definition, some important relations like $\log(m+n)$, $\log\left(\frac{m}{n}\right)$, $\log m^n$, change of base ($\log_e 2 \rightarrow \log_e x$). Application in the calculation of pH.

Curve sketching: How a curve is sketched with a set of points: linear and non-linear (asymptotic) with a set of points, sketching both linear and non-linear curves. Calculation of slope in the case of linear curve. Extrapolation of linear curve and arriving at a limiting value.

Parabolic curve- maximum and minimum. *Differentiation:* Meaning and derivative of functions like e^x , $\log x$, $\sin x$, $\cos x$, $\frac{1}{x}$, x^2 , x^x and \sqrt{x} , $\frac{dy}{dx} = 0$ at maximum and minimum.

2nd order differentiation: for maximum and minimum (derivation from first principles not required). Rules of differentiation for $y = u + v$, $y = uv$, $y = \frac{u}{v}$ and $y = ku$, where k is constant.

Partial differentiation: Explanation, applications using the equation, $H = U + PV$ and $G = H - TS$.

Integration: Meaning and integrals of functions like, x , dx , x^2 , $\frac{1}{x}$, $\frac{1}{x^2}$, $\frac{1}{x^3}$, x^n , e^x , $\sin x$ and $\cos x$. simple problems from I and II order kinetics.

Exact and inexact differentials: Examples from internal energy and enthalpy. *Definite integrals.*

Probability: some definitions, examples from atomic orbitals, wave functions and entropy.

Gaseous state

9 hours

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

Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Derivation of critical constants T_c , P_c and V_c from van der Waal's equation and their experimental determination by Cagniard de La Tour method for T_c and P_c . Amagat's mean density method for V_c . Problems on the calculation of T_c , P_c and V_c , a and b .

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

UNIT-II

Photochemistry

4 hours

Laws of photochemistry. Grotthus-Draper law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemical and thermal reactions. Quantum yield of photochemical combination of (i) H_2 and Cl_2 (ii) H_2 and Br_2 (iii) dissociation of HI (iv) dimerisation of anthracene. Photosensitization, photostationary

equilibrium. Singlet and triplet states. Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensors.

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

Liquids and Solutions

9 hours

Properties of liquids-Viscosity, Surface tension and Parachor-Definition, mathematical expression, numerical problems and factors affecting them.

Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it.

Surface Tension-Definition, mathematical expression, effect of temperature and solute on it

Parachor-Definition, Sugden equation, calculation and applications. Numerical problems.

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions.

Completely miscible liquids-Fractional distillation Tc curves for all the three types, azeotropic mixtures -examples.

Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system.

Immiscible liquids-Steam distillation and its applications.

Distribution law-Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction

Dilute solutions- Review of colligative properties and concentration terms

Determination of molecular mass of a solute by: (i) Berkeley-Hartley's method (π); (ii) Beckmann's method (ΔT_f) and (iii) Landsberger's method. Numerical problems.

UNIT-III

Periodic Table and Periodic properties

9 hours

Review of the modern periodic table (with respect to classification of elements based on outer electronic configuration)

Periodic properties: Atomic and ionic radii, ionisation energy, electron affinity and electronegativity. Trends in the periodic properties. Applications in predicting and explaining chemical behaviour. Factors affecting the values of ionisation energy. Determination of electronegativity by Pauling's method. Diagonal relationship between beryllium and aluminium. Comparative study of elements of alkali and alkaline earth metals, chalcogens and halogens with respect to electronic configuration, atomic and ionic radii, ionisation energy, and electronegativity. Halides, oxides and carbonates of alkali and alkaline earth metals. Hydrides of chalcogens and halogens.

Analytical Chemistry

4 hours

Errors: Classification, minimization of determinate errors, accuracy and precision. Significant figures and their computations.

Equivalent weights of acids, bases, salts, oxidising and reducing agents. Methods of expressing concentration of solutions in terms of Normality and Molarity. Numerical problems.

UNIT-IV

Basic concepts in organic chemistry

4 hours

Bond cleavage – homolytic and heterolytic. Types of reagents – electrophilic and nucleophilic reagents. Reactive intermediates - generation and relative stabilities of carbocation, carbanion, carbon free radicals and carbenes – explanation for stability and reactivity based on inductive, resonance and hyperconjugation effects.

Types of reactions - addition, substitution and elimination. Concept of isomerism - structural isomerism, stereo isomerism - geometrical and optical isomerism, chiral center – definition and examples. Tautomerism (keto – enol).

Aliphatic Hydrocarbons

9 hours

Alkanes: Sources, Nomenclature of branched chain alkanes, preparation of symmetrical and unsymmetrical alkanes- Corey- House reaction and Wurtz reaction - their merits and demerits.

Conformational analysis of n-butane - Sawhorse and Newman projection formulae to be used - Energy profile diagram.

Cycloalkanes: Nomenclature. Method of formation. Explanation for stability based on heat of hydrogenation data, Baeyer's strain theory and its limitation, Sachse - Mohr theory of strain-less rings; cyclopropane ring - banana bonds.

Alkenes: Preparation of alkenes by Wittig reaction-stereoselectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Reactions: Hydroboration- oxidation, reduction, oxymercuration - demercuration, epoxidation. Mechanism of oxidation with KMnO_4 and OsO_4 . Ozonolysis- mechanism and importance.

Dienes: Classification- isolated, conjugated, cumulated. Structure of allene and butadiene. 1,2 addition and 1,4 addition reactions. Diels Alder reaction-1,3-butadiene with maleic anhydride.

Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction – significance. Oxidation with KMnO_4 , acidic nature of terminal alkynes.

**B. Sc., – II Semester
Paper- II**

UNIT-I

Quantum Mechanics and Atomic Structure

13 hours

Review of Bohr's atomic model:

Derivation of expressions of for radius, energy and ionisation energies of hydrogen like atoms. Numerical Problems.

Limitations of classical mechanics. Wave particle duality, Uncertainty principle.

New quantum mechanics-Sinusoidal wave (Explain sinusoidal wave.) equation (classical wave mechanics); Schrodinger wave equation- derivation. Postulates of quantum mechanics.

Significance of terms- (i) Hamiltonian operator; (ii) eigen function Ψ (significance of ψ and ψ^2); (iii) eigen values.

Application of Schrodinger equation: (i) to particle in one dimensional box (derivation required); (ii) to the hydrogen atom (detailed solution not required)

Expressing the solution as a product of $\psi_{n, l, m}(r, \theta, \phi) = \psi_{n, l}(r)\psi_{l, m}(\theta, \phi)$

Explanation of quantum numbers (only qualitative). Radial probability distribution and angular probability distribution. Orbitals

UNIT-II

Chemical bonding

13hours

Ionic bond: Lattice energy, Born-Haber cycle, Born-Lande equation (derivation not required, problems on Born-Lande expression to be worked out). Calculation of lattice energies of NaCl and MgO, effect of lattice energy on solubility of ionic compounds.

Covalent bond: Valence bond approach: hybridization and directional characteristics of sp , sp^2 , sp^3 , sp^2d , sp^3d^2 . Shapes of $BeCl_2$, BF_3 , $SiCl_4$, PCl_5 , SF_6 . VSEPR theory: shapes of CH_4 , NH_3 , NH_4^+ , H_2O , BrF_3 , ICl_2^- . Molecular orbital theory: H_2 , He^{2+} , Be_2 , N_2 , O_2 , O_2^- , O_2^{2-} , O_2^+ and CO (bond order, stability and magnetic properties to be discussed). Polarization concept, Fajan's rule, bond length, bond angle and bond energy, polar and non-polar molecules, dipole moment.

Weak interactions: i). Hydrogen bond: Intra molecular and Intermolecular types, anomalous properties of HF, H_2O , NH_3 , alcohols, carboxylic acids, nitro phenols and bio molecules.

ii) van der Waal's forces: Noble gases and molecular crystals (dry ice, Iodine and solid SO_2)

Metallic bond: Band theory, electrical properties of metals, semiconductors and insulators.

UNIT-III

Silicates

2hours

Structure of SiO_4^{4-} , Classification of silicates based on the structure. Zeolites: their structure and applications.

Noble gases

3hours

Introduction, isolation of Helium from Natural gas, applications of Noble gases. Preparation properties and structures of fluorides and oxides of Xenon (XeF_2 , XeF_4 , XeF_6 , XeO_3 , XeO_4).

General study of d and f block elements.

8hours

Transition elements: electronic configuration, atomic and ionic radii, ionisation energy, oxidation states, redox potentials, spectral and magnetic properties, catalytic activity, interstitial compound formation.

Lanthanides and Actinides: Electronic configuration, atomic and ionic sizes, lanthanide contraction and its consequences. Oxidation states, spectral and magnetic properties, comparison of oxidation states, complex formation and magnetic properties of d and f block elements. Ion exchange method for separation of Lanthanides.

UNIT-IV

Aromatic hydrocarbons

9 hours

Nomenclature. Structure of benzene - using molecular orbital theory. Criteria for aromaticity-Huckel's rule (Examples: cyclopentadienyl anion, cycloheptatrienylcation, benzene, naphthalene, anthracene and phenanthrene). Antiaromaticity.

General mechanism of aromatic electrophilic substitution. Mechanism of nitration of benzene including evidence for the formation of nitronium ion, energy profile diagram and isotopic effect. Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol.

Aromatic nucleophilic substitution *via* benzyne intermediate, mechanism with evidences for the formation of benzyne by trapping with anthracene, Birch reduction. Side chain oxidation of toluene to benzaldehyde and benzoic acid. Oxidation of naphthalene, anthracene and phenanthrene. Diels-Alder reaction of anthracene with 1,2-dichloroethene.

Alkenyl benzenes: Styrene, *cis*- and *trans*-stilbenes and their preparations.

Biphenyl: Preparation-Ullmann reaction.

Organic halogen compounds

4 hours

Alkyl halides: Nomenclature. Nucleophilic substitution reactions - S_N1 and S_N2 mechanisms with energy profile diagrams. Effect of (i) nature of alkyl groups, (ii) nature of leaving groups, (iii) nucleophiles and (iv) solvents on S_N1 and S_N2 mechanisms. Elimination reactions - $E1$ and $E2$ mechanisms; Hofmann and Saytzeff eliminations with mechanism.

Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

**B. Sc., –III Semester
Paper III**

UNIT-I

Chemical Kinetics

7 hours

Review of terms –Rate, Order and Molecularity.

Derivation of expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, half-life period, mean life period and order of reaction.

Determination of order of reaction: differential method, method of integration, method of half-life period and isolation method.

Theories of reaction rates: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Problems.

Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Steady state approximation and Lindemann's hypothesis.

Experimental determination of kinetics of: (i) inversion of cane sugar by polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

Thermodynamics I

6 hours

Exact and inexact differentials. Review of terms, I law of Thermodynamics.

Work done (derivation with problems) in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used).

Heat capacity of a gas at constant pressure and constant volume: relation between P, V and T in an adiabatic process to be derived. Derivation of Kirchoff's equation. Numerical problems.

Spontaneous and non-spontaneous processes.

Second law of thermodynamics: Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity. Other forms of II law of thermodynamics. Concept of entropy and its physical significance-illustrations with order, disorder, physical and chemical processes and probability.

Heat engine-Carnot's cycle and derivation of the expression for its efficiency. Problems based on efficiency equation. II law in terms of efficiency (η). Change in entropy in reversible and irreversible processes (derivations required) . Calculation of entropy changes in reversible isothermal and reversible adiabatic processes. Phase transitions in terms of Entropy (Fusion, vaporization, sublimation and polymorphic changes) in terms of entropy. Limitations of the entropy concept of spontaneity. Problem on Phase transitions

UNIT-II

Thermodynamics II

4 hours

Gibb's free energy: Work function, chemical potential. Definition and relationship between free energy and work function. Criteria for equilibrium and spontaneous processes. Gibb's-Helmholtz equation-Derivation. Change of free energy with respect to temperature and pressure. Mention of temperature coefficient, van't Hoff isotherm (derivations included), $\Delta G^\circ = -RT \ln K_p$. Problems.

Derivation of van't Hoff reaction isochore and Clausius-Clapeyron equation. Its applications to ΔT_b and ΔT_f determination (thermodynamic derivation not required).

Qualitative treatment of Nernst heat theorem and III law of thermodynamics-statement only. Elementary concept of residual entropy.

Surface chemistry **4hours**

Review of surface phenomena.

Theories of adsorption . Adsorption isotherms and BET equation (derivation included), Adsorption indicators. Surface film on liquids.

Catalysis –Types and theories ((intermediate compound theory and adsorption theory).

Heterogeneous catalysis: surface reactions, unimolecular, bi-molecular surface reactions. pH dependence of rate constant of catalysed reactions. Autocatalysis.

Organic and Inorganic Polymers **3hours**

Differences between inorganic and organic polymers.

Polymerisation: types: addition and condensation polymerisation

Molecular weight of Polymers: Expression for Weight average and Number average (experimental determination is not required)

Preparation and applications of the following types of polymers

1. Plastics: i)thermosetting plastics(Phenol-formaldehyde)
ii) thermo softening plastics(PVC)
2. Fibers: Acrylic, polyamide, polyester types: one example for each
3. Rubber: Neoprene,
4. Fluoro Carbons: Teflon
5. Silicones.

Compounds of some Nonmetals. **2hours**

i) Boron and its compounds: Synthesis, structure and applications of Diborane, Borazole and Boron trifluoride.

ii) Halogens and its Compounds: Bleaching powder: manufacture and its applications.

UNIT-III

Metallurgy **5 hours**

Ellingham's diagrams: Salient features. Selection of reducing agents using Ellingham's diagrams.Extraction of the following metals.

- i) Nickel from sulphide ore
- ii) Thorium from Monazite sand
- iii) Uranium from Pitch blende
- iv) Plutonium from Nuclear waste.

Alcohols and Thiols **8 hours**

Alcohols: Introduction and classification. Methods of preparation - (i) From carbonyl compounds - reduction of aldehydes and ketones (by Meerwein-Ponndorf-Verley reaction); (ii) from acids and esters (by reduction with LiAlH_4); (iii) From alkenes (by hydroboration-oxidation with alkaline peroxide); (iv) hydration of alkenes. Reactions of alcohols: Acidic nature, esterification, oxidation of alcohols with KMnO_4 . Comparison of the reactivity of 1° , 2° and 3° alcohols- Lucas test, oxidation with $\text{K}_2\text{Cr}_2\text{O}_7$.

Glycols: Preparation from alkenes using OsO_4 , KMnO_4 and from epoxides. Oxidation of glycols by periodic acid and lead tetraacetate with mechanisms. Pinacol-pinacolone rearrangement.

Glycerol: Preparation from propene and from oils/fats. Uses. Reactions of glycerol: (i) nitration, (ii) action of concentrated H_2SO_4 and (iii) oxidation by periodic acid.

Thiols: Nomenclature. Methods of formation and chemical reactions (with sodium, NaOH , metal oxides, formation of thioesters and oxidation with mild and strong oxidizing agents). Uses of dithianes. Introduction of umpolung character (reversal of polarity) in carbonyl compounds.

UNIT-IV

Phenols

3 hours

Classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids. Effect of electron withdrawing $-\text{NO}_2$ group and electron donating $-\text{CH}_3$ group on acidity of phenols at *o*-, *m*-, *p*- positions. Pechmann reaction, Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions.

Industrial applications of phenols: Conversion of phenol to (i) aspirin, (ii) methyl salicylate, (iii) salol, (iv) salicyl salicylic acid.

Ethers and Epoxides

4 hours

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

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

Fertilizers

4hours

Introduction(need of fertilizers), functions of essential plant nutrients(N,P,K), Classification of fertilizers with examples. Nitrogenous, Phosphatic and mixed fertilizers with suitable examples. Manufacture of urea and Super phosphate of lime, and their uses. Fertilizer industries in India.

Organometallic compounds

2 hours

Preparation and synthetic applications of Grignard reagents, Organolithium compounds and lithium dialkylcuprates.

**B.Sc., IV -Semester
Paper –IV**

UNIT-I

Phase Equilibria

7 hours

Statement and explanation of the terms with examples for phase (P), component (C) and degree of freedom (F), Definition and significance of phase rule. Derivation of phase rule. Application of phase rule to one component systems-water and sulphur, -modified form of phase rule to two component systems. Water-potassium iodide and lead-silver systems. Eutectic mixtures and their applications (examples: freezing mixtures, desilverisation of lead by Patterson's method).

Solid state

6 hours

Crystalline state, Laws of crystallography. Symmetry elements in crystals, crystal systems. Weiss and Miller indices. X-ray diffraction of crystals-derivation of Bragg's equation, . Problems
Liquid crystals-Types with examples. Applications
Superconducting solids-High temperature superconductors. Applications.

UNIT-II

Water Technology

3hours

Types of impurities present in water. Causes for the hardness of water. Permissible levels of ions present in water. Treatment of water for domestic and Industrial purposes by the following methods.

- i) Demineralisation of water by Ion exchange method.
- ii) by reverse Osmosis method.

Nuclear and Radiochemistry.

8hours

Nucleus: Structure and stability, binding energy calculations. Instability of the nuclei, radioactive decay law, half life: numerical problems. Radioactive equilibrium, radioactive series. Artificial radioactivity: Nuclear reactions induced by γ -radiation, α , n, p, and d particles. Nuclear fission and fusion. Nuclear reactors, Breeder reactors, atomic energy programme in India. Isotopes- use of radio isotopes in tracer technique, agriculture, medicine, food preservation and Carbon dating-Numerical problems.

Powder metallurgy

2hours

Advantages of powder metallurgy and its applications. Methods of production of metal powders. production of Tungsten powder from Wulframite.

UNIT-III

Steel

5hours

Iron-Carbon Phase diagram, Austenite, Ferrite, Cementite and Pearlite phases.

Alloy steels: Influence of Si, Mn, Cr, Ni, Ti and W on the properties of Steel.

Ferro alloys: Production of ferro chrome, ferro manganese, and ferro silicon and their applications.

Carbon steel: classification. Heat treatment: hardening, case hardening, carbiding, nitriding, tempering and annealing.

Aldehydes and Ketones

8hours

Nomenclature. Preparation of aldehydes: from acid chlorides (Rosenmund reaction), Gattermann-Koch aldehyde synthesis. Preparation of Ketones: From nitriles, from carboxylic acids with alkyl lithium, from acid chlorides with metal alkyls.

Mechanisms of: Aldol condensation, Perkin condensation, Knoevenagel condensation, Benzoin condensation and Acetal formation. General mechanism of condensation with ammonia and its derivatives ($\text{NH}_2\text{-R}$; $\text{R} = \text{-NH}_2, \text{-OH}, \text{-NH-CO-NH}_2$).

Reduction: Reduction by LiAlH_4 and NaBH_4 . Mannich reaction. Mechanisms of Clemmensen and Wolff-Kishner reductions.

UNIT-IV

Carboxylic acids and their derivatives.

5 hours

Nomenclature. Preparation: Acid hydrolysis of nitriles with mechanism.

Acidic strength (pK_a values) - Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. (comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids ; benzoic and p-nitrobenzoic acid; benzoic acid and p-aminobenzoic acid)

Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Vollhardt-Zelinski reaction, Decarboxylation and reduction (using $LiAlH_4$). (already included under preparation of alcohols from acid)

Di and tri carboxylic acids: Action of heat on dicarboxylic acids (Oxalic to Adipic acids)

Reactions of tartaric acid and citric acid. (action of heat, reduction with HI).

Reactions of acid chlorides (hydrolysis, reaction with alcohol, ammonia and lithium dialkylcuprates) .Acid anhydrides (hydrolysis, reaction with alcohol, ammonia).Esters (alkaline hydrolysis, ammonolysis and alcoholysis).Amides (hydrolysis, reduction, Hoffmann rearrangement). Mechanism of ester hydrolysis - acid and base catalysed (acyl O-cleavage: $B_{AC}2$, $A_{AC}2$; alkyl O-cleavage: $A_{AL}1$ mechanisms).

Tautomerism and Enolates

4 hours

Tautomerism in carbonyl compounds – Keto-Enol tautomerism. Acidity of α -hydrogen atoms in aldehydes, ketones and active methylene compounds (example diethyl malonate, ethyl acetoacetate and acetyl acetone). Preparation of (from acetic acid) and synthetic applications of diethyl malonate (preparation of monocarboxylic acids - butanoic acid, dicarboxylic acid - Adipic acid, unsaturated acids - cinnamic acid, ketones - butanone, cyclic compounds - barbituric acid)

Preparation of ethyl acetoacetate (from ethyl acetate). Synthetic applications of ethyl acetoacetate (preparation of monocarboxylic acids - butanoic acid, dicarboxylic acid –succinic acid, unsaturated acids - crotonic acid, ketones - butanone).

Environmental Chemistry

4hours

Depletion of ozone in the stratosphere. causes and remedial measures. The green-house effect and its consequences. Acid rain, photochemical smog. Treatment of sewage and industrial effluents. Disposal of radioactive wastes.

**B.Sc., - V Semester
Paper V**

UNIT-I

Stereochemistry

8hours

Elements of symmetry in chiral and achiral molecules, chirality, stereogenic centre. Fischer projection formulae.

Enantiomers: Optical activity; use of +/-, *d/l* and *D/L* notations. Properties of enantiomers, chiral and achiral molecules with two stereogenic centers. Meso compounds. Cahn-Ingold-Prelog sequence rules: R, S system of nomenclature.

Diastereomers: Threo and Erythro isomers.

Racemisation and resolution. Relative and absolute configuration.

Optical isomerism due to restricted rotation about single bonds- diphenyl systems.

Geometric isomerism: Determination of configuration of geometric isomers. Cis & trans, E, Z system of nomenclature. Geometric isomerism in oximes.

Alicyclic compounds: Conformations of four to eight membered cycloalkanes and disubstituted cyclohexanes.

Bicyclic systems: Nomenclature and conformations of decalins and norbornane.

UNIT-II

Amines

5hours

Classification. Preparation of alkyl and aryl amines-reductive amination of carbonyl compounds, Gabriel phthalimide synthesis. Basicity of amines in aqueous solution: Inductive, resonance, steric and solvation effects on the basicity of amines. Reaction of amines as nucleophiles – Methylation, quarternary salts, Hoffmann elimination with mechanism. Distinguishing reactions of 1°, 2° and 3° amines.

Diazotization and synthetic applications of diazonium salts. Sandmeyer's reaction. (conversion to chlorobenzene, bromobenzene and benzonitrile), hydrolysis, reduction (to phenyl hydrazine and aniline), coupling reactions to give azo dyes (*p*-hydroxyazobenzene and 1-phenylazo-2-naphthol).

Heterocyclic compounds

4hours

Introduction, classification, structures, resonance and aromatic character of furan, pyrrole, thiophene and pyridine. Methods of preparation and reactions of pyrrole, furan, thiophene, pyridine. Mechanism of electrophilic substitution reactions. Comparison of basicity of pyrrole, pyridine and piperidine. Preparation and reactions of indole, quinoline and isoquinoline.

UNIT-III

Chemistry of Natural Products

10hours

Carbohydrates: Introduction and classification.

Monosaccharides: Aldoses, structures of all the D-aldohexoses. Elucidation of open chain structure of D-glucose. Mechanism of mutarotation and anomeric effect. Elucidation of ring structure of D-glucose in detail.

Ketoses: Fructose, interconversion of glucose and fructose.

Disaccharides: Glycosidic bond. Structures of maltose, lactose and sucrose-Haworth and conformational structures.

Terpenes and terpenoids: Occurrence, classification and isoprene rule. Elucidation of structure and synthesis of citral and zingiberene. Structures of limonene, menthol, α -terpineol, camphor, β -carotene, Vitamins-A and their uses.

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

UNIT-IV

Spectroscopy of Organic compounds

8 hours

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

IR spectroscopy: Introduction. Stretching frequencies of -OH (free and H-bonded), alkyl -C-H , $\text{C}\equiv\text{C}$, $\text{C}=\text{C}$, C-C , C=O and C-O groups (by taking suitable examples). Graphical representation of IR spectra of benzoic acid and methyl benzoate.

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

Applications of NMR spectroscopy including identification of simple organic molecules.

Examples: Shielding and deshielding effects for (i) methane (ii) $\text{CH}_3\text{-Cl}$ (iii) CH_2Cl_2 (iv) CHCl_3 . Spin-spin coupling in (i) Cl_2CHCHO (ii) 1,1,2-trichloroethane (iii) $\text{CH}_3\text{CH}_2\text{Cl}$.

Industrial Organic chemistry

5 hours

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

Drugs: Chemotherapy, classification of drugs. Synthesis and uses of paracetamol, diclofenac, ranitidine, sulphanilamide and chloramphenicol.

Introduction to Green Chemistry: Principles of Green chemistry and its application to the synthesis of paracetamol.

**B. Sc., - V Semester
Paper VI**

UNIT-I

Electrochemistry I

10 hours

Review of electrolytes and Conductance related terms

Methods of determination of molar conductance. Conductometric titrations (only acid-base type). Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Ionic mobility. Problems on transport numbers. Conductivity of water.

Kohlrausch's law and its applications: (i) evaluation of Λ_{∞} from Λ_{+} and Λ_{-} (ii) evaluation of degree of dissociation of a weak electrolyte (iii) evaluation of Λ_{∞} of a weak electrolyte (iv) determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and BaSO₄). Problems based on these.

Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory, Debye-Huckel-Onsagar equation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation.

Galvanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nernst equation for single electrode potential (free energy concept).

UNIT-II

Electrochemistry II

5 hours

Weston-cadmium cell: Determination of emf of a cell by compensation method. Determination of E° of Zn/Zn²⁺ and Cu/Cu²⁺ electrodes. Liquid junction potentials, elimination of liquid junction potential.

Types of electrodes: Metal and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes-standard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Numerical problems.

Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems.

Ionic equilibria

3 hours

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

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

Analytical and biological applications of buffers.

Theories of indicators.

UNIT-III

Physical properties and Molecular structures

5 hours

Polarization and orientation of dipoles in an electric field. Dipole moment. Induced dipole moment (experimental determination of dipole moment not included). Clausius-Mossotti equation (only statement). Dipole moment and structure of molecules (planar and non-planar). Magnetic properties-paramagnetic, diamagnetic and ferromagnetic systems. Electrical properties of solids: types of solids-metals, insulators and semiconductors. Pyroelectricity, piezoelectricity, ferroelectricity, inverse piezoelectricity. Thomson effect, Seebeck effect and Peltier effect-definition with examples.

Chemical Spectroscopy I

5 hours

The interaction of radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques.

Origin of molecular spectra: Born-Oppenheimer approximation.

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

UNIT-IV

Chemical Spectroscopy II

4 hours

Vibrational spectroscopy: Hooke's law- Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy, numerical problems. Degree of freedom of polyatomic molecules- modes of vibration for CO₂ and H₂O molecules.

Raman spectroscopy:

3 hours

Concept of polarisability. Pure rotation, vibration, qualitative study. Stokes and anti-Stokes lines-selection rules.

Advantages of Raman spectroscopy over IR spectroscopy.

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

Electroanalytical Methods

5 hours

Voltammetry at a dropping mercury electrodes (DME)-Types of current obtained at DME. Ilkovic equation and its applications. Current -potential relation for a cathodic process - half wave potential.

Cyclic Voltammetry-Principles-Experimental set up-Quantitative analysis, determination of diffusion coefficients.

**B.Sc., - VI Semester
Paper VII**

UNIT-I

Coordination and Organometallic compounds I

10 hours

Coordination compounds, ligands and their classification (mono, bi, tri, tetra, penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclature of coordination compounds in detail. Theories of structure and bonding (Explanation for the formation of complexes by Werner's Theory in detail and its limitations). EAN rule, Valence bond theory-postulates, low spin and high spin complexes with examples, limitations of VBT. Crystal field theory (octahedral, tetrahedral and square planar complexes). Crystal field splitting and crystal field stabilization energies, limitations of CFT. Magnetic properties of $[\text{CoF}_6]^{3-}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Fe}(\text{CN})_6]^{4-}$, $[\text{Fe}(\text{CN})_6]^{3-}$. Spectral properties of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$, $[\text{CoCl}_4]^{2-}$. Isomerism-Structural: ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism-geometrical and optical isomerism with examples.

Organometallic compounds – ligands, classification (hapticity). Synthesis and structure of $\text{K}[\text{PtCl}_3(\eta^2\text{-C}_2\text{H}_4)]$ and $[\text{Fe}(\eta^5\text{-C}_5\text{H}_5)_2]$,

UNIT-II

Coordination and Organometallic compounds II

4 hours

Metal carbonyls – $\text{Cr}(\text{CO})_6$, $\text{Co}_2(\text{CO})_8$, $\text{Mn}_2(\text{CO})_{10}$; eighteen electron rule and its deviations with examples.

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

Industrial Materials I

6 hours

Refractories: Properties, classification, determination of PCE values.

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

Glass: Properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glass, safety glass, fire and bullet proof glasses.

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

Cement: Raw materials grades, manufacture of Portland cement (by wet process), setting of cement.

UNIT-III

Industrial Materials II

7 hours

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

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

Explosives: Classification, preparation of dynamite and TNT.

Propellants: Characteristics, classification and their applications.

Bioinorganic Chemistry

3 hours

Essential and trace elements in biological systems with reference to Na^+ , K^+ , Ca^{2+} , Fe^{2+} , P, Cu, V and Ni. Metallo-porphyrins with special reference to haemoglobin, myoglobin and chlorophyll. Role of cobalamin (vitamin- B_{12} coenzyme) in living systems.

UNIT-IV

Chemistry of Newer materials

10hours

Conducting polymers: Introduction, definition and examples-polyaniline, polyacetylene. Mechanism of conduction. Qualitative treatment of doping, Properties: elasticity with high electrical conductivities, Engineering and biological applications.

Super conductors: Introduction, definition, type 1, type 2 and atypical. Preparation of high temperature super conductor- $\text{Y}_1\text{Ba}_2\text{Cu}_3\text{O}_{x+\delta}$, BCS theory (qualitative treatment only) and general applications of high temperature super conductors.

Fullerenes: Introduction, definition, preparation and isolation of C_{60} . Structure and Chemical reactions (redox reactions, electrophilic aromatic substitution and bromination) of C_{60} . Commercial uses of C_{60} . Carbon nanotubes-Introduction, definition, examples and structure.

Nanomaterials: Introduction, definition and electronic structure. Different methods of production: Sol gel synthesis, inert gas condensation, mechanical alloying (ball milling), plasma synthesis, electrodeposition, and general applications.

**B.Sc., - VI SEMESTER
Paper – VIII**

UNIT-I

INTRODUCTION TO BIOCHEMISTRY

2hours

Contributions of Lavoisier, Wohler, Emil Fischer, Louis Pasteur, Embden, Meyerhof, Parnas, Hans Krebs, Michaelis and Menton, Watson and Crick, Chargaff, H.G. Khorana, Knoop, Pauling, Hopkins and Miescher. Elemental and biochemical composition of living organisms. Role of water in biochemical systems (mention the properties of water which makes water a solvent of life).

CARBOHYDRATES

4hours

Structure and biological importance of derivatives of monosaccharides.

Amino sugars : β -D-glucosamine, galactosamine and their N-acetylated forms: N-acetylmuramic acid (NAMA); N-acetylneuraminic acid (NANA)

Sugar acids—structure and biological importance of D-gluconic acid, D-glucuronic acid and D-glucaric acid.

Sugar phosphates—structure and biological importance of Glucose-6-P, Fructose-6-P, Fructose-1,6-di-P, β -D-ribose-5-P and β -D-deoxyribose-5-P.

Structure and biological importance of oligosaccharides – isomaltose, cellobiose, trehalose.

Polysaccharides - source, comparative account of partial structure and biological function of starch, glycogen, cellulose, chitin and insulin.

LIPIDS

4hours

Introduction, Classification.

Fatty acids—definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids). Essential fatty acids – definition with examples

Triglycerides—Structure of simple and mixed glycerides, properties of triglycerides- acid and alkali hydrolysis, saponification number and its significance, iodine number and its significance, rancidity (oxidative and hydrolytic), biological importance of triglycerides.

Phosphoglycerides – general structure of 3-Sn-phosphatidic acid, lipid bilayer (as in cell membrane), micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin, phosphatidylserine, phosphatidylinositol.

Cholesterol – definition, types (HDL, LDL and VLDL)

Sphingolipids—structure and biological significance of ceramide.

UNIT-II

PROTEINS

5hours

α -amino acids: Introduction, structure, classification on the basis of polarity of R-groups, essential and non essential amino acids, ionic properties and reactions of amino acids with alcohol, nitrous acid and Ninhydrin.

Levels of organizations of Protein: Primary structure, Secondary structure (α -helix, triple helix eg., Collagen and β -pleated sheet), tertiary structure and forces stabilizing it, quaternary structure.

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

Classification of proteins based on structure, composition and biological function (enzymes, hormones, transport agents, antibodies, structural materials with examples).

NUCLEIC ACIDS

3hours

Types—Components of nucleic acids, bases, nucleosides and nucleotides with structures. Partial structure of polynucleotide.

Structure of DNA (Watson-Crick model) and RNA. Biological roles of DNA and RNAs. Protein-nucleic acid interaction- chromatin and viral nuclear capsid.

HORMONES

2hours

Definition.

Classification - a) amino acid derivatives (epinephrine and thyroxine); b) peptide (oxytocin and vasopressin) and polypeptide hormones (insulin and glucagon); c) Steroid hormones (progesterone, testosterone) with functions.

Role of insulin and glucagon in glucose homeostasis.

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

UNIT-III

ENZYMES

4hours

Introduction, Holo enzyme (apo enzyme and co enzyme). Active site, specificity.

Classification of enzymes (EC code number not required).

Enzyme substrate interaction- Fischer and Koshland models.

Enzyme kinetics—factors affecting rate of enzymatic reactions – enzyme concentration, substrate concentration, pH and temperature (mention M. M. equation).

Allosteric enzymes—definition and example

Enzyme inhibitions-Competitive, noncompetitive and uncompetitive inhibition with one example for each.

BIOLOGICAL OXIDATION

4hours

Bioenergetics- Introduction-stages of energy transformation. Exergonic and endergonic reactions. Relationship between ΔG and K_{eq} .

High energy phosphates—definition, examples, structural features of ATP that makes ATP a high energy phosphate (electro static repulsion, opposing resonance, solvation of ATP).

Examples of high energy phosphates other than ATP. Energy coupling in biological reactions (explain the concept with suitable examples).

Biological oxidation – comparison of oxidation with combustion using glucose as an example. Redox potentials of some biological important half reactions. Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH). Mitochondrial electrotransport chain, oxidative phosphorylation. Substrate level phosphorylation.

BIOCHEMICAL TECHNIQUES**2hours****Principle and applications of:**

- Paper chromatography and TLC.
- Electrophoresis–cellulose acetate membrane electrophoresis and PAGE.

UNIT-IV**METABOLISM****6hours**

Catabolism and anabolism (explanation with an example) – Carbohydrate metabolism, glycolysis, fate of pyruvate. TCA cycle, energetic.

Gluconeogenesis–definition, synthesis of glucose from lactate.

Fatty acid metabolism–activation of fatty acids, role of carnitine, β -oxidation pathway, energetics.

Protein metabolism–general aspects of amino acid degradation – transamination, deamination and decarboxylation. Urea cycle.

MOLECULAR BIOLOGY**4hours**

Central dogma of molecular biology–semi conservative replication and mechanism of DNA replication, transcription, translation.

DNA finger printing – Definition and its applications.

SUGGESTED BOOKS

Inorganic Chemistry

1. Advanced Inorganic Chemistry, 6th Edition
F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann-John Wiley & Sons, 1999.
2. Concise Inorganic Chemistry, 5th Edition
J. D. Lee, Blackwell Science, 2001.
3. Inorganic Chemistry, 4th Edition
J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Inorganic Chemistry, ELBS 2nd Edition
D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
5. Environmental Chemistry
A. K. De, Wiley Eastern Ltd., 1999.
6. Nuclear and Radiation Chemistry
Sharma B. K, Goel Publishing House, 1987.
7. Modern Inorganic Chemistry
W. L. Jolly, McGraw Hill Co.
8. Principles of Inorganic Chemistry
B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
9. Inorganic Chemistry, 3rd Edition (ISE)
A G Sharpe, Addison Wesley, 1989.
10. Basic Inorganic Chemistry, 3rd Edition
F. A. Cotton, G. Wilkinson, P. L. Gaus-John Wiley & Sons, 1995.
11. Essential Chemistry, International Edition
R. Chang, McGraw Hill Co, 1996.
12. University Chemistry, 4th Edition (ISE)
B. H. Mahan & R. J. Myers, Addison Wesley, 1989.
13. Essential Trends in Inorganic Chemistry
C. M. P. Mingos, Oxford Univ Press, 1998
14. Chemistry, 3rd Edition
P. Atkins & L. Jones, W. H. Freeman & Company, 1997.
15. Modern Chemistry, 4th Edition
D. W. Oxley, H. P. Gills & N. H. Nachtrieb, Saunders College Publishing, 1998.
16. Fundamental Concepts of applied Chemistry,
Jayashree Ghosh, S Chand Publications.
17. Industrial Chemistry,
B. K. Sharma, Goel Publishing House

Organic Chemistry

1. Organic Chemistry, Paula Yurkanis Bruice, Prentice Hall, 2005.
2. Advanced Organic Chemistry
F. A. Carey and R. J. Sundberg, Plenum, 1990.

3. Organic Chemistry, Vol I & II
I. L. Finar, ELBS, 1986, 1991, 2005
4. Organic Chemistry
R. T. Morrison and R. N. Boyd, Prentice Hall, 1991
5. Organic Chemistry, Maitland Jones, Jr., W. W. Norton & Company
6. Advanced Organic Chemistry
O. S. Bahl and A. Bahl., S. Chand & Co. 1995
7. Advanced Organic Chemistry
J. March, John Wiley & Sons, 2008.
8. Understanding Organic Reaction Mechanisms
A. Jacobs, Cambridge Univ Press, 1998.
9. Organic Chemistry
M. K. Jain, Nagin & Co., 1987
10. A Guide to Mechanism in Organic Chemistry
P. Sykes, Orient Longman, 2005.
11. Organic Spectroscopy
V. R. Dani, Tata McGraw Hill, 1998.
12. Organic Spectroscopy
W. Kemp, ELBS IV Edition, 1998.
13. Synthetic Drugs
G. R. Chatwaal, Himalaya Publications, 2000.
14. Stereochemistry of Organic Compounds ,
Ernest L. Eliel, Samuel H. Wilen, Wiley India Edition, 1994

Physical Chemistry

1. Physical Chemistry, 7th Edition
P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
2. The Elements of Physical Chemistry, 3rd Edition
Peter Atkins, Oxford Univ. Press, 2000.
3. Physical Chemistry – A molecular Approach
Donal A. Mcquarrie and John D. Simon, Viva Low-priced Student Edition, 2001.
4. Introduction to Physical Chemistry, 3rd Edition
Mark Ladd, Cambridge Low-Priced Edition, 1999.
5. Text Book of Physical Chemistry
S. Glasstone, MacMillan India Ltd., 1998.
6. Principles of Physical Chemistry, 4th Edition
B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987
7. Text Book of Physical Chemistry
P. L. Soni., S. Chand & Co., 1993.
8. Physical Chemistry
Alberty R. A. and Silbey R. J. John Wiley & Sons, 1992.
9. Physical Chemistry
G. M. Barrow, McGraw Hill, 1986.
10. Physical Chemistry, 3rd Edition
Gibert W. Castellan, Narora Publishing House, 1985.

11. Text Book of Polymer Science
Billmeyer, Dr. F. W. John Wiley & Sons, 1984.
12. Basic Physical Chemistry
Walter J. Moore, Prentice Hall, 1972.

Biochemistry

1. Concise Text Book of Biochemistry
T. N. Pattabhiraman, All India Publishers, 2000.
2. Biochemistry
A. L. Lehninger et. al., CBS, 2000.
3. A Text Book of Biochemistry
A. V. S. S. Rama Rao, UBSPD, 1998.
4. Biochemistry
P. C. Champe and R. A. Harvey, J. B. Lipincott & Co, 1982.
5. Fundamentals of Biochemistry
J. L. Jain, S. Chand & Co., 1983.
6. Biochemistry
COSIP-ULP, Bangalore University, 1981.
7. Outlines of Biochemistry
Conn E. E and Stumpf P. K., John Wiley & Sons, 1978.
8. General Biochemistry
Weil J. H., Wiley Eastern
9. Biochemistry Campbell M. K., Harcourt Brace & Co.

Chemistry Practicals for B. Sc., Course

I Semester: Practical 1 (General Chemistry)

3 hours per week

1. Calibration of glass wares: (i) Pipette (ii) Burette (iii) Volumetric flask
2. Estimation of potassium permanganate using standard sodium oxalate solution.
3. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with potassium ferricyanide as an external indicator.
4. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with diphenyl amine as an internal indicator. (Change to ferroin indicator?)
5. Estimation of sodium thiosulphate using standard potassium dichromate solution.
6. Estimation of iodine using sodium thiosulphate and standard potassium dichromate solution.
7. Determination of the percentage of available chlorine in the given sample of bleaching powder.
8. Determination of percentage of manganese dioxide from pyrolusite ore.
9. Estimation of chloride by Mohr's method (using potassium chromate as an adsorption indicator).
10. Estimation of chloride by Volhard's method.
11. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
12. Estimation of nitrogen in an ammonium salt using sodium hydroxide solution and standard oxalic acid.
13. Estimation of carbonate and bicarbonate in a given mixture.

Note: Standard solutions to be prepared for experiments 2 to 6.

II Semester: Practical II (Physical Chemistry)

3 hours per week

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of percentage composition of a binary liquid mixture by viscosity method.
3. Determination of molar mass of polymer by viscosity method.
4. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
5. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
6. Determination of degree of dissociation of an electrolyte by ebullioscopic method.
7. Determination of transition temperature of a salt hydrate by thermometric method.
8. Determination of distribution coefficient of acetic acid between water and butanol.
9. Determination of distribution coefficient of benzoic acid between water and toluene.
10. Effect of surfactants on the surface tension of water (Stock solution to be given).

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

Preparation and purification of organic compounds

1. Recrystallisation and determination of melting point of solids (mixed melting point determination and its importance may be mentioned).
2. Simple distillation and determination of boiling point of liquids.
3. Purification of solids by sublimation.

One stage preparation

(Preparation, recrystallization and melting point determination of the recrystallised sample)

4. Preparation of aspirin from salicylic acid.
(*Note: Acetic anhydride is to be prepared freshly by distilling acetyl chloride and sodium acetate mixture*).
5. Preparation of paracetamol from *p*-aminophenol.
6. Preparation of dibenzalacetone from benzaldehyde (using acetone-alcoholic sodium hydroxide).
7. Preparation of *p*-aminobenzoic acid from *p*-nitrobenzoic acid.
8. Preparation of *m*-dinitrobenzene from nitrobenzene.
9. Preparation of benzoic acid from benzaldehyde.

Two stage preparations

10. Preparation of *p*-bromoaniline from acetanilide.
11. Preparation of *p*-nitroaniline from acetanilide.
12. Preparation of *m*-nitrobenzoic acid from methyl benzoate.
13. Preparation of methyl orange/methyl red by diazotization and coupling.

Chromatography

14. **Paper chromatography:** Extraction of spinach (using 1 : 1 alcohol and Whatmann filter paper)
15. **Thin layer chromatography:** Separation of green leaf pigments/separation of a mixture of two organic compounds.
16. **Column chromatography:** Separation of a mixture of two organic compounds

IV Semester: Practical IV (Inorganic Chemistry)**3 hours per week**

1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (with no interfering radicals).
2. Separation of metal ions (Cu^{2+} , Co^{2+} , Ni^{2+} , Fe^{2+}) using paper chromatography and calculation of R_f values (To be performed by the students)
3. Separation of Mg(II) and Fe(II) by solvent extraction technique.
4. Effluent analysis.

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

1. Organic qualitative analysis of mono functional organic compounds through functional group analysis. Determination of physical constant. Preparation and characterization of a suitable derivative.
2. Isolation of lycopene from tomatoes.
3. Isolation of caffeine from tea leaves.

VI Semester: Practical VI (Physical Chemistry)**3 hours per week**

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
2. Determination of velocity constant for the saponification of ethyl acetate ($a = b$).
3. The study of kinetics of potassium persulphate and potassium iodide colorimetrically.
4. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
5. Determination of dissociation constant of monochloroacetic acid by conductivity method.
6. Conductometric titration of hydrochloric acid with sodium hydroxide.
7. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
8. Determination of Critical Micellar Concentration (CMC) by conductivity method.
9. Determination of pK_a of a weak acid by pH metric method.
10. To construct the phase diagram of two component system (Ex. diphenylamine-benzophenone) by cooling curve method.
11. Determination of percentage of sodium chloride by miscibility temperature method.
12. Estimation of Cu^{2+} colorimetrically and verification of Beer-Lambert's law.
13. Determination of Oxidation and Reduction potential of $K_4Fe(CN)_6/K_3Fe(CN)_6$ system by cyclic voltammetry.

VI Semester: Practical VII (Inorganic Chemistry)**3 hours per week**

1. Estimation of percentage of iron in haematite using bariumdiphenylamine sulphonate as an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of copper in brass.
4. Estimation of zinc using EDTA.
5. Estimation of total hardness of water using EDTA.
6. Gravimetric estimation of barium as barium sulphate.
7. Gravimetric estimation of nickel as nickel dimethyl glyoximate.
8. Preparation of cuprammoniumsulphate and determination of λ_{max} and hence CFSE.
9. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
10. Estimation of nickel using EDTA and standard zinc sulphate.
11. Preparation of ferrous oxalate and its analysis (both iron and oxalate).

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

1. Preparation of buffers and determination of their pH values using pH meter.
2. Estimation of reducing sugars by Hegdorn-Jensen method.
3. Estimation of lactose in milk by Nelson-Somyogi's method.
4. Estimation of creatinine by Jaffe's method.
5. Estimation of inorganic phosphate by Fiske-Subbarow method.
6. Estimation of total reducing sugars by DNS (dinitrosalicylic acid) method.
7. Isolation of lactose and casein from milk and estimation of lactose by colorimetric method.
8. Estimation of α -amino acids using ninhydrin by colorimetric method.
9. Determination of blood group.
10. Separation of α -amino acids by paper chromatography.
11. Isolation of DNA from onions.
12. Estimation of cholesterol by colorimetric method.
