BSc Chemistry Syllabus

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications, the syllabus pertaining to B.Sc. (3 Year Degree Course) in the subject of Chemistry has been prepared as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills. This B.Sc course of Chemistry consists of 3 year course with semester system - in all six semesters (two semesters in a year). Total marks: 1500 (500 per year and 250 per semester) of core discipline.

BSc Sem I

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Inorganic Chemistry	BCH101	80	20
2	Organic Chemistry/Physical Chemistry	BCH102	80	20
5	Lab Course I	BCH10P	40	10

BSc Sem II

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Inorganic Chemistry	BCH201	80	20
2	Organic Chemistry/Physical Chemistry	BCH202	80	20
5	Lab Course II	BCH20P	40	10

BSc Sem III

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Inorganic Chemistry/ Physical Chemistry	BCH301	80	20
2	Organic Chemistry	BCH302	80	20
5	Lab Course III	BCH30P	40	10

BSc Sem IV

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Inorganic Chemistry/ Physical Chemistry	BCH401	80	20
2	Organic Chemistry	BCH402	80	20
5	Lab Course IV	BCH40P	40	10

BSc Sem V

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Physical Chemistry	BCH501	80	20

2	Organic Chemistry/ Inorganic Chemistry	BCH502	80	20
5	Lab Course V	BCH50P	40	10

BSc Sem VI

S. No.	Paper	Paper Code	Max Marks (100)	
			Ext.	Int.
1	Physical Chemistry	BCH601	80	20
2	Organic Chemistry/ Inorganic Chemistry	BCH602	80	20
5	Lab Course VI	BCH60P	40	10

Semester I (90 lectures)

Paper I: Inorganic Chemistry

1. Atomic Structure and Periodic Properties (16 Lecture)

Bohr's model, Summerfield's extension, de Broglie's wave particle duality; Heisenberg's uncertainty principle and Schrödinger's equation (qualitative); significance of ψ and ψ^2, radial density, angular probability, Quantum numbers and their significance. Aufbau principle, Pauli's exclusion/ant symmetry principle (statement and implication), Hund's rules, Slater's rules, quantum defect; Brief discussion of the following properties of the elements, with reference to s & p-block and the trends shown:

a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
b) Atomic and ionic radii
c) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods.
d) Electron gain enthalpy and trends in groups and periods.
e) Electro negativity, Pauling's scale. Variation of electro negativity with bond order, partial charge.

2. Chemical Bonding & Ionic Solids (14 Lecture)

Covalent bond: Valence Bond theory (Heitler-London approach). Concept of hybridization; Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_3, PCl_5, SF_6, ClF_3, I_3^-, BrF_2^+, PCl_6^-, ICl_2^- ICl_4^- and SO_4^{2-}.

Molecular orbitals (MO) approach of bonding (LCAO Method). Symmetry and overlap, symmetry of molecular orbitals, Bonding in Homonuclear molecules (H_2 to Ne_2) and NO, CO, CN^+, CO^+, CN^-, HF, HCl, CO_2, Comparison of VB and MO theories.

Covalent character in ionic compounds, Fajan's rules and consequences of polarization; Percentage Ionic character in covalent compounds, Dipole moment

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals; Lattice defects, semiconductors, lattice energy and Borne-Haber cycle. Solvation energy and solubility of ionic solids

Weak interactions-hydrogen bonding and Van der Waals forces

3. s-block elements **(5 Lecture)**

General discussion with respect to all periodic and chemical properties, diagonal relationship, chemical reactivity and trends in alkali and alkaline earth metals; structure and properties of Hydrides, oxides, halides and hydroxides, coordination complexes, Organometallic compounds of alkali metals, Crown and Crypts, Role of alkali and alkaline earth metal ions in bio-systems

4. p-b lock elements & Chemistry of Noble gases **(10 Lecture)**

General discussion and comparative study (all periodic and chemical properties) including diagonal relationship, of groups 13 to 17 elements; chemistry of elements-hydrides, oxides & oxy-acids, and halides (including inter-halogen compounds). Diborane-properties & structure, borohydrides, carbides, fluorocarbons, basic properties of iodine and polyhalides. Inert-pair effect: in heavier elements of 13, 14 & 15 group elements; its consequences in redox properties of their halides. Chemistry of noble gasses.

Books Suggested:

Inorganic Chemistry:

1. J.D. Lee Concise, Inorganic Chemistry, ELVS.
2. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand &
5. Company, New Delhi.
6. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhii. I.L. Finar, Organic Chemistry, Pearson.

Paper II: Organic Chemistry/Physical Chemistry

1. Structure and Bonding in organic compounds, and Mechanism of Organic Reactions (9 Lectures)

Hybridization, Shapes of molecules bond lengths and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clatherates, charge transfer complexes resonance, aromaticity, Inductive, electromeric, resonance and mesomeric effects, hyperconjugation, dipole moment; hydrogen bonding (Applications to be discussed with relevant topics).

Homolytic and Heterolytic fission with suitable examples. Curved arrow notation, drawing electron movements with arrows, half headed and double headed arrows, formal charges; Electrophiles and Nucleophiles; Types, shape and relative stability of Carbocations,

Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions: Addition, Elimination and Substitution reactions. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

2. Stereochemistry of Organic Compounds **(12 Lectures)**

Concept of isomerism, Types of isomerism

Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogeric centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.

Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds

Conformational isomerism – conformational analysis of ethane and n-butane; conformational analysis of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivative, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae.

Difference between configuration and conformation

3. Gaseous, Liquid and Solid States **(18 Lecture)**

Kinetic theory of gases, Deviation of real gases from ideal behaviour, compressibility factor; van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomenon, critical constants and their calculation from van der Waals equation; Laws of corresponding states.

Molecular velocities: Root mean square, average and most probable velocities, qualitative discussion of the Maxwell's distribution of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance., collision number, mean free path and collision diameter, liquefaction of gases (based on Joule-Thomson effect):

Intermolecular forces, structure of liquids (a qualitative description) Structural differences between solids, liquids and gases. Physical properties of liquids including their methods of determination: surface tension, viscosity and refractive index. Liquid crystals, Difference between liquid crystal, solids and liquids.

Definition of space lattice, unit cell, crystal planes, 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's equation; Determination of crystal structure of NaCl, KCl and CsCl by Laue's method and powder methods.

4. Colloidal State **(6 Lecture)**

Definition of colloids, classification of colloids. Solids in liquids (sols): properties – kinetic, optional and electrical; stability of colloids, protective action, Hardy-Schulze law, gold

number. Liquids in liquids (emulsions): types of emulsions, preparation, emulsifier. Liquids in solids (gels): classification, preparation and properties, inhibition, general application of colloids.

Books Suggested:

Organic Chemistry:

1. E. L. Eliel, Stereochemistry of Organic Compounds, Willey.
2. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
3. S.M. Mukerji and Singh. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand.
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.

Physical Chemistry:

1. Atkins P.W., Physical Chemistry, Oxford University Press.
2. Bell D.W., Physical Chemistry, Thomson Press.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tull, Essential of Physical Chemistry, S. Chand & Company, New Delhi.

Lab Course B.Sc. I st semester (4hours)

1. Mixture analysis for six radicals including interfering radicals and combination tests. Cations : $NH4^+$, Pb^{2+}, Ag^+, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+ Anions : CO_3^{2-}, S^{2-}, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$ 12 marks

2. (i) Detection of extra element (N, S, X) in the organic compounds (containing two elements). 4×2 marks

   (ii) Detection of functional groups in the organic compounds (containing two functional groups).

3.(i) Determination of relative surface tension of a liquid and its parachor value. 10 marks

(ii) Determination of relative coefficient of viscosity of a liquid and its Rheochor value.

4. Viva 5 marks

5. Record 5 marks

Semester II (90 lectures)

Paper I: Inorganic Chemistry

1. Chemistry of Transition Elements (First Transition Series) (8 Lecture)

Characteristic properties of the elements; ionic radii, oxidation states, complex compound formation and magnetic properties. Their binary compounds, illustrating relative stability of their oxidation states, coordination number and geometry.

2. Chemistry of Transition Elements (Second and Third Series) (6 Lecture)

General characteristics, comparative treatment with their analogues in respect of ionic radii, oxidation state, magnetic behaviour and stereochemistry.

3. Chemistry of Lanthanides and Actinides (10 Lecture)

Electronic structure, oxidation states, ionic radii, lanthanide contraction and its consequences, complex formation, methods of separation of lanthanidesfractional crystallization, fractional precipitation, change in oxidation state, solvent extraction and ion exchange methods. General features of actinides-electronic configuration, atomic and ionic radii, ionization potential, oxidation states and complex formation.

4. Metal Carbonyls and Nitrosyls (10 Lecture)

Definition, nomenclature and classification based on nature of metal-carbon bond. Metal carbonyls. Mononuclear carbonyls, nature of bonding, structure and preparation. EAN and 18-electron rule. Definition, nomenclature, classification, general methods of preparation of organometallic compounds and a brief account of metal-ethylenic complexes. Applications of organometallic compounds-Ziegler-Natta catalyst, Wilkinson catalyst (No mechanism). Metal nitrosyl compounds, nitrosyl carbonyls. Dinitrogen and dioxygen complexes, tertiary phosphines as ligand.

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2. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand &
5. Company, New Delhi.
6. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhii. I.L. Finar, Organic Chemistry, Pearson.

Paper II: Organic Chemistry/Physical Chemistry

1. Alkanes, alkenes, alkynes and dienes (20 Lecture)

Nomenclature, classification and isomerism in alkanes, methods of preparations physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity. Cycloalkanes- nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations; Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring-bent or banana bonds.

Nomenclature of alkenes , methods of formation, mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff Rule, Hoffmann Elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes -mechanisms involved in electrophilic and free radical additions,

Markownikoff's Rule, hydroborationoxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$, Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes.

Methods of formation, and chemical reactions of cycloalkenes.

Nomenclature and classification of dienes; isolated, conjugated and cumulative dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions- 1,2 and 1,4 additions, Diels -Alder reaction.

Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration- oxidation, metal- ammonia reduction, oxidation and polymerization.

2. Arenes and Aromaticity; Alkyl and Aryl Halides (12 Lecture)

Structure of benzene: molecular formula and Kekule structure. Stability and carbon –carbon bond length of benzene, resonance structure, MO picture. Aromaticity –the Hückel rule. Aromatic electrophilic substitution –general pattern of the mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.

Methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides, SN_2 and SN_1 reactions with energy profile diagrams. Methods of formation of aryl halides, nuclear and side chain reactions. The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactiviteis of alkyl halides vs. allyl, vinyl and aryl halides.

3. Thermodynamics (Second and Third Law) (14 Lecture)

Brief introduction of First Law of Thermodynamics and related topics;

Second law of thermodynamics, need of the law, different statements of the law; Carnot cycle and its efficiency, Carnot theorem; Thermodynamic scale of temperature; Concept of entropy: entropy as a state function, entropy as a function of V and T, entropy as a function of P and T, entropy change in physical and chemical processes, entropy change in reversible and irreversible processes. Clausius inequality, entropy as criteria of spontaneity and equilibrium; Entropy change in ideal gases and mixing of gases;

Gibbs and Helmoltz functions; Gibbs function (G) and Helmoltz function (A) as thermodynamic quantities, A and G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G and A with P, V and T; Gibbs-Helmoltz equation, Clapeyron equation, Clausius-Clapeyron equation, reaction isotherm and reaction isochore;

Statement and concept of residual entropy, third law of thermodynamics, unattainability of absolute zero, Nernst heat theorem. Evaluation of absolute entropy from heat capacity data

4. Chemical Kinetics (10 Lecture)

Rates of reactions, rate constant, order and molecularity of reactions. Differential rate law and integrated rate expressions for zero, first, second and third order reactions. Half-life time of a reaction. Methods for determining order of reaction. Effect of temperature on reaction rate and the concept of activation energy. Reaction mechanism. Steady state hypothesis. Homogeneous catalysis, Acid-base catalysis and enzyme catalysis (Michaelis-Menten equation). Heterogeneous catalysis. Unimolecular surface reactions.

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4. Elementary Spectroscopy, Y.R. Sharma, S. Chand,
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.
6. Jagdamba Singh, Undergraduate Organic Chemistry Vol.-I, Pragati Prakashan

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4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.

Lab Course B.Sc. IInd semester (4 hours)

1. (a) Redoxtitration: (i) Iodometry (ii) $Fe^{2+}/K_2Cr_2O_7$ 12 marks
   (b) Hardness of water by EDTA methods.
2. Organic synthesis involving nitration, halogenations, sulphonation, oxidation and benzoylation. 8 marks
3. (i) Determination of transition temperature of inorganic substances. 10 marks
   (ii) Construction of phase diagram of a two component system.
   (iii)Determination of heat capacity of calorimeter for different volumes.
4. Viva 5 marks
5. Record 5 marks

Semester III (90 lectures)

Paper I: Inorganic Chemistry/Physical Chemistry

1. Coordination Chemistry-I (10 Lecture)

Werner's theory for coordination compounds; its experimental verification, effective atomic number (EAN) concept, chelates. Nomenclature of coordination compounds (IUPAC system), isomerism in coordination compounds, stability of complexes and factors contributing to the stability; Valence Bond Theory (VBT) for coordination compounds, magnetic properties of complex compounds.

2. Coordination Chemistry-II: Metal-Ligand Bonding in transition Metal Complexes (8 Lecture)

Limitations of valence bond theory, an elementary idea about crystal field theory; crystal field splitting octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters. Jahn Teller Distortion in complexes.

3. Chemical and Ionic Equilibrium (14 Lecture)

General characteristics of chemical equilibrium, thermodynamic derivation of the law of chemical equilibrium, Van't Hoff reaction isotherm. Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between G and G°; Relation between Kp, Kc and Kx. Temperature dependence of equilibrium constant-Van't Hoff equation, homogeneous & heterogreneous equilibria, Le Chetalier's principle.

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

4. Electrochemistry (10 Lecture)

Specific conductance, molar conductance and their dependence on electrolyte concentration. Ionic Equilibria and conductance, Essential postulates of the Debye-Huckel theory of strong electrolytes. Mean ionic activity coefficient and ionic strength. Transport number and its relation to ionic conductance and ionic mobility.

Conductometric titrations. pH scale. Buffer solutions, salt hydrolysis. Acid-base indicators.

Distinction between electrolytic and electrochemical cells. Standard EMF and electrode potential. Types of electrodes Reference electrode. Calculation of ΔG, ΔH, ΔS and equilibrium constant from EMF data. Potentiometric determination of pH. Potentiometric titrations.

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3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand &
5. Company, New Delhi.
6. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhii. I.L. Finar, Organic Chemistry, Pearson.

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2. Bell D.W., Physical Chemistry, Thomson Press.

3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.

Paper II: Organic Chemistry

1. Alcohols and Phenols **(16 Lecture)**

Alcohols: Classification and nomenclature. Monohydric alcoholsmethods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols. Dihydric alcohols-methods of preparation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)4 and HIO4], esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation and pinacol-pinacolone rearrangement. Trihydric alcohols-methods of formation, chemical reactions of glycerol.

Phenols: Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Electrophilic substitution: Nitration, halogenation and sulphonation, acylation and carboxylation, Mechanism of Fries rearrangement,Reimer-Tiemann Reaction, Claisen condensation, Lederer-Manasse reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

2. Ethers and Epoxides **(6 Lecture)**

Ethers: Structure, Physical properties, preparation (Williamson synthesis). Reactions : Cleavage by acids, Electrophilic substitution in ethers.

Expoxides: Preparation: From Halohydrins, Peroxidation of Carbon-carbon double bonds. Reactions with acid, base and Grignard reagents.

3. Chemistry of Carbonyl compounds (aldehydes and Ketones) (12 Lecture)

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis from acid chlorides, synthesis using 1,3-dithianes, from nitriles and carboxylic acids. Physical properties. Mechanism of nucleophilc additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation. Condensation with ammonia and its derivatives; Wittig reaction, Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, LiAlH4 and NaBH4 reductions. Halogenation of enolizable ketones. An introduction to α-, β-unsaturated aldehyde and ketones.

4. Carboxylic Acids and derivatives (14 Lecture)

Carboxylic Acids: Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Methods of formation and chemical reactions of halo acids.

Hydroxy acids: maleic, tartaric and citric acids. Methods of formation and chemical reactions of unsaturated monocarboxylic acids.

Dicarboxylic acids: methods of formation and effect of heat and dehydrating agents.

Carboxylic acid derivatives: Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.
Preparation of carboxylic acid derivatives, chemical reactions. Mechanism of esterification and hydrolysis (acidic and basic).

Books Suggested:

Organic Chemistry:

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3. S.M. Mukerji and Singh, Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand,
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.
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Lab Course B.Sc. III semester (4 hour)

1. Inorganic preparations: 8 marks
   (i) Cuprous chloride
   (ii) Potash alum
   (iii) Chrome alum
   (iv) Ammonium ferric sulphate
   (v) Ferrous oxalate

3. Identification of simple organic compounds (formation of derivatives not included). 12 marks

3. (i) Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 10 marks
   (ii) Determination of enthalpy of solutions (NH_4NO_3 & $CaCl_2$).
   (iii) Separation of amino acids and sugars by paper / TLC chromatography.
4. Viva 5 marks
5. Record 5 marks

Semester IV (90 lectures)

Paper I: Inorganic Chemistry/Physical Chemistry

1. Thermodynamic and Kinetic Aspects of Coordination Compounds (8 Lecture)

A brief outline of thermodynamic and kinetic stability of metal complexes and factors affecting the stability of coordination compounds. Substitution reactions in square planar complexes.

2. Magnetic Properties of Transition Metal Complexes **(8 Lecture)**

Types of magnetic behaviour, methods of determining magnetic susceptibility; Gouy's and Quincke's methods, spin only formula, correlation of μs and μeff values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

3. Physical Properties and Molecular Structure **(8 Lecture)**

Optical properties and their relation with chemical constitution, polarization, Clausius-mossotti equation, orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and its application in determining the structure of molecules.

4. Surface Chemistry, Catalysis and Phase Equilibrium **(16 lecture)**

Bulk phases and interfacial region, types of interfaces; Surface tension and interfacial tension. Adsorption of gases on solids, chemisorption and physi-sorption, desorptoin. Adsorption isotherms; theories of adsorption, Langmuir isotherm, Freundlich isotherm, Adsorption and catalysis; Catalysis, characteristics of catalyzed reactions, classification of catalysis, miscellaneous examples.

Statement and meaning of the terms: phase, component and degree of freedom, derivation of Gibbs phase rule. One component systems-water, sulphur, carbon dioxide, helium. Phase equilibria of two component systems: solid-liquid equilibra, simple eutectic; Bi-Cd, Pb-Ag systems, desilverisation of lead; construction and interpretation of general phase diagrams for liquid vapour, liquid-liquid and liquid-solid systems.

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2. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand &
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6. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhii. I.L. Finar, Organic Chemistry, Pearson.

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3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.

Paper II: Organic Chemistry

1. Nitrogen Containing Organic Compounds **(14 Lecture)**

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium. Picric acid. Halonitroarenes-reactivity, structure and nomenclature of amines. Physical properties. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabrielphthalimide reaction, Hofmann bromamide reaction. Reaction of amines, electrophilic aromatic substitution in aryl amines, reaction of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

2. Chemistry of Carbohydrates **(10 Lecture)**

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, inetrconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. General study of disaccharides (structure determination not required). General introduction of structure of ribose and deoxyribose.

3. Amino Acids, Peptides, Proteins and Nucleic Acids **(14 Lecture)**

Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation and reactions of á-amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solidphase peptide synthesis. Structures of peptides and proteins. Levels of protein structure. Protein denaturation.

Nucleic acids : Introduction. Constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.

4. Heterocyclic Compounds **(12 Lecture)**

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 derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction of condensed five- and six membered heterocycles. Preparation and reactions of quinolene and isoquinolene with special reference to Fischer-Indole synthesis, Skraups synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of quinolene and isoquinolene.

Books Suggested:

Organic Chemistry:

1. E. L. Eliel, Stereochemistry of Organic Compounds, Willey.
2. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.

3. S.M. Mukerji and Singh. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand,
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.
6. Jagdamba Singh, Undergraduate Organic Chemistry Vol.-I, Pragati Prakashan

Lab B.Sc. IV semester (4 hour)

1. Preparation of inorganic complex compounds : 8 marks
(i) Tetraammine copper sulphate (ii) Prussian blue (iii) Hexammine nickel (II) chloride
(iv) Potassium trioxalato chromate (III) (v) Hexaammine cobalt (III) chloride.
2. Estimation of functional groups such as –OH, $-NH_2$, –CHO, –COOH etc. 12 marks
3. (i) Kinetics of First order reaction. 10 marks
(ii) Viscosity-composition curve for a binary mixture.
(iii) Determination of strength of unknown acids or bases by using pHmetry.
5. Viva 5 marks
6. Record 5 marks

Semester V (90 lectures)

Paper II: Physical Chemistry

1. Elementary Quantum Mechanics **(14 Lecture)**

Quantum mechanics of simple systems: Schrodinger's wave equation, and time dependent Schrodinger's wave equation, postulates of quantum mechanics, Eigen functions and eigen values and quantum mechanical operatore. Expectation value of a physical quantity. Orthogonality of wave functions. The particle in a one dimensional box problem and its solutions. Particle in three dimensional box. Degeneracy, rigid rotor and harmonic oscillator.

2. Molecular Spectroscopy **(14 Lecture)**

Region of electromagnetic spectrum, emission and absorption spectra, signal to noise ratio and resolving power, width and intensity of spectral transitions, pure rotational spectra, diatomic rigid rotor molecules, effect of isotope substitution, vibrational and vibration-rotational spectra of diatomic molecules, harmonic oscillator-rigid rotor approximation, anharmonicity effect, normal modes of vibration, infrared spectra of linear and bent AB2 molecules, electronic spectra of diatomic molecules, vibrational structure, Franck-Condon principle.

3. Photochemistry **(12 Lecture)**

Interaction of radiation with matter, difference between thermal and photochemical rocesses. Laws of photochemistry; Grothuss-Drapper law, Lambert's law, Lambert-Beer's law, Stark-

Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

4. Energy and Distribution Law **(6 Lecture)**

Degrees of freedom, types of energies in linear and non-linear molecules, derivation and applications of Maxwell-Boltzmann distribution law.

Books Suggested:

Physical Chemistry

1. Atkins P.W., Physical Chemistry, Oxford University Press.
2. Bell D.W., Physical Chemistry, Thomson Press.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.
6. G Joshi, R Verma, R Bahuguna and S Kothiyal, Integrated Instrumental methods in spectroscopic and separation techniques Pragati Publication Meerut

Paper II: Inorganic Chemistry/Organic Chemistry

1. Basics of Bioinorganic Chemistry **(10 Lecture)**

Introduction of bioinorganic chemistry, General properties of biological molecules, physical methods in bio-inorganic chemistry, Binding of metal ions and complexes with biomolecule active centers, Atoms and group transfer chemistry, Electron transfer in Proteins

2. Inorganic Pulymers of Silicones and Phosphates **(8 Lecture)**

Silicones; siloxanes, silicone rubber, polymethylhydrosiloxanes, applications. Phosphazenes, nature of bonding in triphosphazenes. Zeolites.

3. Organo-Metallic Compounds & Organic Synthesis via Enolates **(16 Lecture)**

Organic derivatives of lithium and magnesium – their preparation, properties and reactions. Organocopper intermediates; Organozinc compounds; formation and chemical reactions. Synthetic applications of other transition metals; Nomenclature, structural features, methods of formation and chemical reactions of thiols, thioethers, sulphonic acid, sulphonamides and sulphaguanidine.

Acidity of methylene hydrogen, alkylation of diethylmalonate and ethylacetoacetate. Synthesis of ethylacetoacetate, the Claisen condensation. Keto-enol tautomerism of ethylacetoacetate. Synthetic uses of ethylacetoacetate and diethylmalonate.

4. Synthetic Polymers and Synthetic dyes **(10 Lecture)**

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step-growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubber.

Colour and constitution (electronic concept), classification of dyes. Synthesis and uses of Methyl orange, Malachite green, Phenolphthalein, Fluorescein, Alizarin and Indigo.

Books Suggested:

Inorganic Chemistry:

1. J.D. Lee Concise, Inorganic Chemistry, ELVS.
2. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand &
5. Company, New Delhi.
6. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhii. I.L. Finar, Organic Chemistry, Pearson.

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3. S.M. Mukerji and Singh. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand,
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.

Lab Course B.Sc. V semester (6 hour)

1. Gravimetric estimations of copper-zinc, copper-nickel and silver-copper in their respective solutions — 12 marks
2. Separation of binary mixture of organic compounds (solid-solid). — 10 marks
3. (i) Determination of equilibrium constant of methyl acetate hydrolysis reaction. 8 mark
   (ii)Potentiometric titration: Acid-base.
   (iii)Order of reaction of I_2/Acetate/H^+.
4. Viva — 5 marks
5. Record — 5 marks

Semester VI (90 lectures)

Paper I: Physical Chemistry

1. Basics of NMR and Mass Spectrometry (10 Lecture)

Principle and Instrumentation of NMR spectroscopy, nuclear shielding and deshielding. Factors affecting chemical shift, Spin coupling, Applications of NMR spectroscopy. Applications of NMR spectroscopy. Introduction and Principle of Mass Spectrometry; Instrumentation of Mass Spectrometer Ion Source or Ionization Chamber Electron-Impact ionisation (EI-MS) Chemical Ionisation (CI-MS); m/z peak; Applications of mass spectroscopy.

2. Introduction to Nuclear Chemistry (14 Lecture)

Nuclear Chemistry: Classification of nuclides, nuclear stability and binding energy, atomic energy. Radioactivity: general characteristics of radioactive decay kinetics, artificial radioactivity, detection and measurement of radioactivity: GM counter.
Nuclear Reactions: Types of nuclear reactions, conservation of linear momentum and mass-energy in nuclear reactions, nuclear reaction cross section. Compound nucleus theory and its experimental verification; nuclear fission process, fission energy;
Interaction of nuclear radiations with matter- charged particle, neutrons and gamma rays. Radiolysis of water and aqueous solutions, radiation dosimetry.

3. Solutions and Colligative Properties **(12 Lecture)**

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solutions, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular mass determination. Osmosis, law of osmotic pressure and its measurement, determination of molecular mass from osmotic pressure. Elevation of boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

4. Separation Techniques **(10 Lecture)**

Introduction to Analytical Chemistry and its interdisciplinary nature; Concept of sampling; Importance of accuracy, precision and sources of error in analytical measurements; Presentation of experimental data and results, from the point of view of significant figures; Definition, general introduction on principles of chromatography, Qualitative and quantitative aspects of chromatographic methods of analysis: paper chromatography, TLC etc. IC, GLC, GPC, and HPLC. Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation.

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1. Atkins P.W., Physical Chemistry, Oxford University Press.
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3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
4. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
5. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.
6. Essentials of Nuclear Chemistry, H.J. Arnikar, 4th Edition, (2003) New Age International Publishers, New Delhi
7. G Joshi, R Verma, R Bahuguna and S Kothiyal, Integrated Instrumental methods in spectroscopic and separation techniques Pragati Publication Meerut

Paper II: Inorganic Chemistry/Organic Chemistry

1. Introduction of Supramolecular, Nano & Green Chemistry **(10 Lecture)**

Definition, molecule to supramolecule, molecular aggregate to crystalline aggregate; synthetic methods: choice of building units, reaction condition, design of structures: nano and mega carbon tubes, meso structures, nanoclusters and nanowires; applications. Principles and concepts of green chemistry, Need for Green Chemistry. Goals of Green Chemistry; Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity, green solvents,

2. Acids and Bases, Hard soft acids and bases & Non aqueous Solvents (14 Lecture)

Various definitions of acids and bases, A generalized acid-base concept, Measurement of acid-base strength, Lewis interactions in non-polar solvents, Systematics of Lewis acid-base interactions, Bond energies, steric effects, solvation effects and acid-base anomalies, Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.

Classification of solvents, their general characteristics, physical properties of the solvents, reaction in nonaqueous solvents-liquid NH3 and SO2 (auto-ionization, precipitation reactions, acid-base reaction, oxidation-reduction reactions, salvation and solvolysis, complex formation), merits and demerits;

3. Spectroscopy and It's use in structure determination of organic molecules

(12 Lecture)

Infrared Spectroscopy, Principle of IR; fundamental vibrational modes; factors affecting vibrational frequencies; energy, selection rules, and transition frequency for harmonic and an-harmonic diatomic oscillator; Instrumentation of IR; Introduction and principle of Ultraviolet and Visible spectroscopy; Beer Lambert Law; energy, selection rules, and transition frequency for diatomic molecule; Instrumentation of UV spectrophotometer; Applications of UV-Vis, IR and NMR in the structure determination of simple organic molecules.

4. Introduction to Medicinal Chemistry (8 Lecture)

Introduction to medicinal chemistry, Drug discovery, design and development; Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim).

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3. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
4. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand &
5. Company, New Delhi.

6. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhii. I.L. Finar, Organic Chemistry, Pearson.
7. J.M. Lehn, Supramolecular Chemistry, VCH
8. Geoffrey A. Ozin, and Andre Arsentte,Neno Chemistry, RSC Publishing
9. Green Chemistry: Environmentally benign reactions V K Ahluvalia 2007

Organic Chemistry:

1. E. L. Eliel, Stereochemistry of Organic Compounds, Willey.
2. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
3. S.M. Mukerji and Singh. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
4. Elementary Spectroscopy, Y.R. Sharma, S. Chand.
5. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.
6. New Trends in Green Chemistry, V K Ahluvaia and M Kidvai, Anamaya Publication New Delhi 2004

Lab Course B.Sc. VI semester (6 hour)

1. Volumetric and gravimetric analysis of inorganic elements. 12 marks

2. Two step organic synthesis :' 10 marks

a) Nitrobenzene to metadinotroaniline
b) Benzaldehyde to banzamide
c) Benzaldehyde to Benzil
d) Aniline to p-Bromobenzanilide

3.(i) Conductometric titrations: Acid-base. 8 marks

(ii) Kinetics of catalytic decomposition of H_2O_2.

(iii) Determination of PH of the given solution using glass electrods.

(iv) Surface tension-composition curve for a binary liquid mixture.

4. Viva 5 marks
5. Record 5 marks