Scheme and Syllabi
for B.Sc. Part-I, Part-II and Part-III (Chemistry) w.e.f. 2014-2015, 2015-2016 and 2016-2017

B.Sc. Part-I (Ist Semester)

Paper No.	Code No.	Nomenclature	Max. Marks Written + I.A#.	Time
I	CH-101	Inorganic Chemistry (Th)*	32 + 8	3 hrs.
II	CH-102	Inorganic Chemistry (Th)	32 + 8	3 hrs.
III	CH-103	Organic Chemistry (Th)	32 + 8	3 hrs.

***Th means Theory, # I.A. means Internal Assessment.**

B.Sc. Part-I (IInd Semester)

Paper No.	Code No.	Nomenclature	Max. Marks Written + I.A.	Time
IV	CH-104	Inorganic Chemistry (Th)	32 + 8	3 hrs.
V	CH-105	Physical Chemistry (Th)	32 + 8	3 hrs.
VI	CH-106	Organic Chemistry (Th)	32 + 8	3 hrs.
VII	CH-107	Practicals	60 **(No Internal Assessment in Practical Exam)**	7 hrs.

Note: Practical Exam will be held at the end of 2nd Semester

Total Marks of I & II Semesters = 120 + 120 + 60 = 300

B.Sc. Part-II (IIIrd Semester)

Paper No.	Code No.	Nomenclature	Max. Marks Written + I.A.	Time
VIII	CH-201	Inorganic Chemistry (Th)	32 + 8	3 hrs.
IX	CH-202	Physical Chemistry (Th)	32 + 8	3 hrs.
X	CH-203	Organic Chemistry (Th)	32 + 8	3 hrs.

B.Sc. Part-II (IVth Semester)

Paper No.	Code No.	Nomenclature	Max. Marks Written + I.A.	Time
XI	CH-204	Inorganic Chemistry (Th)	32 + 8	3 hrs.
XII	CH-205	Physical Chemistry (Th)	32 + 8	3 hrs.
XIII	CH-206	Organic Chemistry (Th)	32 + 8	3 hrs.
XIV	CH-207	Practicals	60 **(No Internal Assessment in Practical Exam)**	7 hrs.

Note: Practical Exam will be held at the end of 4th Semester

Total Marks of III & IV Semesters = 120 + 120 + 60 = 300

B.Sc. Part-III (Vth) Semester

Paper No.	Code No.	Nomenclature	Max. Marks Written + I.A.	Time
XV	CH-301	Inorganic Chemistry (Th)	32 + 8	3 hrs.
XVI	CH-302	Physical Chemistry (Th)	32 + 8	3 hrs.
XVII	CH-303	Organic Chemistry (Th)	32 + 8	3 hrs.

B.Sc. Part-III (VIth Semester)

Paper No.	Code No.	Nomenclature	Max. Marks Written + I.A.	Time
XVIII	CH-304	Inorganic Chemistry (Th)	32 + 8	3 hrs.
XIX	CH-305	Physical Chemistry (Th)	32 + 8	3 hrs.
XX	CH-306	Organic Chemistry (Th)	32 + 8	3 hrs.
XXI	CH-307	Practicals	60 **(No Internal Assessment in Practical Exam)**	7 hrs.

Note: Practical Exam will be held at the end of 6^{th} Semester

Total Marks of V & VI Semesters = 120 + 120 + 60 = 300

TOTAL MARKS OF CHEMISTRY in B.Sc. degree = 300 × 3 = 900

B. Sc. Ist Year (Ist Semester)

Paper-I (CH-101) Inorganic Chemistry (Theory)

M. Marks: 32 **Time:3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section – A (23 periods)

Atomic Structure

Idea of de Broglie matter waves, Heinsenberg's uncertainty principle, atomic orbitals, quantum numbers, radial and angular wave functions, normal and orthogonal wave functions, significance of Ψ and Ψ^2, probability distribution curves, shapes of s, p, d, f orbitals, Aufbau and Pauli exclusion principles, Hund's multiplicity rules, Electronic configuration of elements, effective nuclear charge, Slater's rules.

Periodic table and atomic properties

Classification of periodic table into s, p, d, f blocks, atomic and ionic radii, ionisation energy, electron affinity and electronegativity definition, methods of determination or evaluation, trend in periodic table (in s and p-block elements), Pauling , Mulliken, Allred Rachow and Mulliken Jaffe's electronegativity scale, Sanderson's electron density ratio.

Section – B (22 periods)

Covalent Bond

Valence bond theory (Heitler-London and Pauling approach) and its limitation, directional characteristics of covalent bond, various type of hybridisation and shapes of simple inorganic molecules and ions (BeF_2, BF_3, CH_4, PF_5, SF_6, IF_7, SO_4^{-2}, ClO_4^{-1}, NO_3^{-1}) valence shell electron pair repulsion (VSEPR) theory to NH_3, H_3O^+, SF_4, ClF_3, H_2O, $SnCl_2$, ClO_3^{-1} and ICl_2^{-1}. Molecular orbital theory of homonuclear (N_2, O_2) heteronuclear (CO and NO) diatomic molecules and ions, bond energy, bond angle, bond length and dipole moments, percentage ionic character from dipole moment and electronegativity difference.

Ionic Solids

Ionic structures (NaCl, CsCl, ZnS (Zinc blende), CaF_2) size effects, radius ratio rule and its limitations, Madelung constant, Stoichiometric and Non stoichiometric defects in crystals, Lattice energy (mathematical derivation excluded) and Born-Haber cycle, Solvation energy and its relation with solubility of Ionic solids, Polarizing power and Polarisability of ions, Fajan's rule.

B. Sc. Ist Year (Ist Semester)
Paper-II (CH-102) Physical Chemistry (Theory)
M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section– A (23 Periods)

Gaseous States

Kinetic Molecular Theory of Gases, Maxwell' s distribution of velocities and energies (derivation excluded) Calculation of root mean square velocity, average velocity and most probable velocity. Collision diameter, collision number, collision frequency and mean free path (Derivations excluded), Deviation of Real gases fro m ideal behavior, Derivation of Van der Waal' s Equation of State, i ts application in the calculation of Boyle' s temperature (compression factor)

Critical Phenomenon

Critical temperature, critical pressure, critical volume and their determination. PV isotherms of real gases, continuity of states, the isotherms of Van der Waal' s equation, relationship between critical constants and Van der Waal' s constants. Critical compressibility factor. The Law of corresponding states.

Section- B (22 Periods)

Liquid States

Structure of l iquids, Properties of l iquids – surface tension, refractive index, viscosity, vapour pressure and optical rotation.

Solid State

Classification of solids, Law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry and symmetry elements, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of Laue method, rotating crystal method and powder pattern method.

B. Sc. Ist Year (Ist Semester)

Paper-III (CH-103) Organic Chemistry (Theory)

M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section-A (23 Periods)

Structure and Bonding

Localized and delocalized chemical bond, Van der Waal' s interactions, resonance: conditions, resonance effect and i ts applications, hyperconjugation, inductive effect, Electromeric effect & their comparison.

Stereochemistry of Organic Compounds

Concept of isomerism. Types of isomerism.

Optical isomerism — elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.

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

Geometric isomerism — determination of configuration of geometric isomers. E & Z system of nomenclature,

Conformational isomerism — conformational analysis of ethane and n- butane, conformations of cyclohexane, axial and equatorial bonds. Newman projection and Sawhorse formulae, Difference between configuration and conformation.

Section- B (22 Periods)

Mechanism of Organic Reactions

Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents – electrophiles and nucleophiles. Types of organic reactions.

Reactive intermediates — carbocations, carbanions, free radicals, carbenes,(formation, structure & stability).

Alkanes and Cycloalkanes

IUPAC nomenclature of branched and unbranched alkanes, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation: Wurtz reaction, Kolbe reaction, Corey- House reaction and decarboxylation of carboxylic acids, physical properties.

Mechanism of free radical halogenation of alkanes: reactivity and selectivity.

Cycloalkanes — nomenclature, synthesis of cycloalkanes and their derivatives – photochemical (2+2) cycloaddition reactions, , dehalogenation of α,ω-dihalides, , pyrolysis of calcium or barium salts of dicarboxylic acids, Baeyer's strain theory and its limitations., theory of strainless rings.

B.Sc. Ist Year (IInd Semester)

Paper-IV (CH-104) Inorganic Chemistry (Theory)

M.Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q.No.1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section – A (23 periods)

Hydrogen Bonding and Van der Waals forces

Hydrogen Bonding – Definition, types, effects of hydrogen bonding on properties of substances, application

Brief discussion of various types of Van der Waals forces.

Metallic Bond and semiconductors

Metallic bond – Qualitative idea of valence bond and Band theories of metallic bond (conductors, semiconductors, insulators).

Semiconductors – Introduction, types and applications.

s-Block elements

Comparative study of the elements including diagonal relationship, Anomalous behaviour of Lithium and Beryllium compared to other elements in the same group, salient features of hydrides, oxides, halides, hydroxides (methods of preparation excluded), behaviour of solution in liquid NH_3.

Chemistry of Noble Gases

General physical properties, low chemical reactivity, chemistry of xenon, structure and bonding in fluorides, oxides and oxyfluorides of xenon.

Section – B (22 periods)

p-Block elements:

Electronic configuration, atomic and ionic size, metallic character, melting point, ionization energy, electron affinity, electronegativity, inert pair effect and diagonal relationship.

Boron family (13th group):
Diborane: Preparation, properties and structure (as an example of electron deficient compound and multicenter bonding), Borazine chemical properties and structure, relative strength of Trihalide of Boron as lewis acids, structure of aluminium(III) chloride.

Carbon family and Nitrogen family (14th and 15th group):
Catenation, Carbides, fluoro carbons, silicates (structural aspects).
Oxides: Structure of oxides of nitrogen and phosphorus, Oxyacids : Structure and relative acid strength of oxy acids of nitrogen and phosphorus, structure of white and Red phosphorus.

Oxygen family (16th group):
Oxy acids of sulphur – structure and acidic strength, Hydrogen Peroxide – properties and uses.

Halogen family (17th group):
Interhalogen compounds (their properties and structures), Hydra and oxy acids of chlorine – structure and comparison of acid strength, cationic nature of Iodine.

B. Sc. Ist Year (IInd Semester) Paper-V (CH-105) Physical Chemistry (Theory)

M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section–A (22 Periods)

Kinetics

Rate of reaction, rate equation and its types, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light, catalyst. Order of a reaction, integrated rate expression for zero order, first order, second and third order reactions. Half life period of a reaction. Effect of temperature on the rate of reaction – Arrhenius equation. Theories of reaction rate – Simple collision theory for unimolecular collision. Transition state theory of bimolecular reactions.

Section-B (23 Periods)

Electrochemistry

Electrolytic conduction, factors affecting electrolytic conduction, specific conductance, molar conductance, equivalent conductance and relation among them, their variation with concentration. Arrhenius theory of ionization, Ostwald' s Dilution Law. Debye-Huckel – Onsager' s equation for strong electrolytes (elementary treatment only), Application of Kohlrausch' s Law in calculation of conductance of weak electrolytes at infinite dilution. Applications of conductivity measurements: determination of degree of dissociation, determination of K_a of acids determination of solubility product of sparingly soluble salts, conductometric titrations. Concepts of pH and pK_a , Buffer solution, Buffer action, Henderson – Hazel equation, Buffer mechanism of buffer action.

B. Sc. Ist Year (IInd Semester)
Paper-VI (CH-106) Organic Chemistry (Theory)
M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section-A (23 Periods)

Alkenes

Nomenclature of alkenes, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halide. The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes.

Chemical reactions of alkenes—mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration–oxidation, oxymercuration-reduction, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$.

Arenes and Aromaticity

Nomenclature of benzene derivatives: Aromatic nucleus and side chain.

Aromaticity: the Huckel rule, aromatic ions, annulenes up to 10 carbon atoms, aromatic, anti- aromatic and non- aromatic compounds.

Aromatic electrophilic substitution — general pattern of the mechanism, mechansim of nitration, halogenation, sulphonation, and Friedel- Crafts reaction. Energy profile diagrams. Activating , deactivating substituents and orientation.

Section-B (22 Periods)

Dienes and Alkynes

Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of butadiene. Chemical reactions — 1 , 2 and 1 , 4 additions (Electrophilic & free radical mechanism), Diels- Alder reaction, Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of e lectrophilic and nucleophilic addition reactions, hydroboration-oxidation of alkynes.

Alkyl and Aryl Halides

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms and stereochemistry of nucleophilic substitution reactions of alkyl halides, S_N2 and S_N1 reactions with energy profile diagrams.

Methods of formation and reactions of aryl halides, The addition-elimination and the elimination- addition mechanisms of nucleophilic aromatic substitution reactions.

Relative reactivities of alkyl halides *vs* allyl, vinyl and aryl halides.

B.Sc. I Year
Paper-VII (CH-107) Practicals

M.Marks:60 **Time: 7 Hrs.**

(One day in two sessions i.e. 9:00AM-12:30PM and 1:30PM-5:00PM)

Section-A (Inorganic)

Volumetric Analysis

1. Preparation of reference solutions.
2. **Redox titrations**: Determination of Fe^{2+} , $C_2O_4^{2-}$ (using $KMnO_4$, $K_2Cr_2O_7$)
3. **Iodometic titrations:** Determination of Cu^{2+} (using standard hypo solution).
4. **Complexometric titrations:** Determination of Mg^{2+} , Zn^{2+} by EDTA.

Paper Chromatography

Qualitative Analysis of any one of the following Inorganic cations and anions by paper chromatography (Pb^{2+} , Cu^{2+} , Ca^{2+} , Ni^{2+} , Cl^- , Br^- , I^- and PO_4^{3-} and NO_3^-).

Section-B (Physical)

1. To determine the surface tension of at least two liquids using stalagmometer by drop no. and drop weight methods (Use of organic solvents excluded).
2. To study the effect of surfactant on surface tension of water.
3. To determine the viscosity of at least two liquids by using Ostwald's viscometer (Use of organic solvents excluded).
4. To determine the specific refractivity of at least two liquids.

Section–C (Organic)

1. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point or boiling point
   (i)) Iodoform from ethanol (or acetone)
   (ii) i) *m*-Dinitrobenzne from nitrobenzene (use 1:2 conc. HNO_3-H_2SO_4 mixture if fuming HNO_3 is not available)
   iii) i) p-Bromoacetanilide from acetanilide
   iv) Dibenzalacetone from acetone and benzaldehyde
   v) 2,4-DNP derivative of Benzophenone/ Acetophenone.
2. To study the process of (i) sublimation (ii) Crystallization of camphor and phthalic acid

Distribution of marks

1.	Section- A	15 marks
2.	Section- B	15 marks
3.	Section- C	15 marks
4.	Viva- voce	05 marks
5.	Lab Record	10 marks

B. Sc. II Year (IIIrd Semester)
Paper- VIII (CH-201) Inorganic Chemistry (Theory)

M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section – A (23 periods)

Chemistry of d-Block elements

Definition of transition elements, position in the periodic table, General characteristic properties of d-Block elements, Comparison of properties of 3d elements with 4d and 5d elements with reference only to ionic radii, oxidation state, magnetic and spectral properties and stereo chemistry.

Stability of various oxidation states and e.m.f (Latimer and Frost diagrams), Structure and properties of some compounds of transition elements- TiO_2, $VOCl_2$, $FeCl_3$, $CuCl_2$ and $Ni(CO)_4$.

Section – B (22 periods)

Coordination Compounds

Werner's theory of coordination compounds, effective atomic number, chelates, nomenclature of coordination compounds, Isomerism in coordination compounds, valence bond theory of transition metal complexes.

Non-aqueous solvents

Physical properties of solvents, types of solvents and their general characteristics, reactions in non aqueous solvents with reference to liquid NH_3 and liquid SO_2.

B. Sc. IInd Year (IIIrd Semester)
Paper-IX (CH-202) Physical Chemistry (Theory)
M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section– A (23 Periods)

Thermodynamics

Definition of thermodynamic terms: system, surrounding etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Thermodynamic equilibrium, Concept of heat and work.

First law of thermodynamics: statement, concepts of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule– Thomson coefficient for ideal gas and real gas and inversion temperature. Calculation of w, q, d U & d H for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

Section- B (22 Periods)

Chemical Equilibrium

Equilibrium constant and free energy, concept of chemical potential, Thermodynamic derivation of law of chemical equilibrium. Temperature dependence of equilibrium constant. Clausius–Clapeyron equation and its applications.

Distributioln Law

Nernst distribution law – i ts thermodynamic derivation, Applications of distribution law: (i) Determination of degree of hydrolysis and hydrolysis constant of aniline hydrochloride (i i) Determination of equilibrium constant of potassium tri - iodide complex and (i i i) Process of extraction. More stress on numerical problems.

B. Sc. IInd Year (IIIrd Semester)
Paper- X (CH-203) Organic Chemistry (Theory)
M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section-A (23 Periods)

Alcohols

Monohydric alcohols — nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols.

Dihydric alcohols — nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement.

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. Reactions of phenols — electrophilic aromatic substitution, Mechanisms of Fries rearrangement, Claisen rearrangement, Reimer- Tiemann reaction, Kolbe' s reaction and Schotten and Baumann reactions.

Epoxides

Synthesis of epoxides. Acid and base- catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Section-B (22 Periods)

Ultraviolet (UV) absorption spectroscopy

Absorption laws (Beer- Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones, Woodward- Fieser rules, calculation of λ_{max} of simple conjugated dienes and α,β-unsaturated ketones.

Applications of UV Spectroscopy in s tructure elucidation of simple organic compounds.

Carboxylic Acids & Acid Derivatives

Nomenclature of Carboxylic acids, 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. Reduction of carboxylic acids. Mechanism of decarboxylation.

Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Mechanisms of esterification and hydrolysis (acidic and basic).

B. Sc. II Year (IVth Semester)

Paper- XI (CH-204) Inorganic Chemistry (Theory)

M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section – A (23 periods)

Chemistry of f-Block elements

Lanthanides: Electronic structure, oxidation states, magnetic properties, complex formation, colour, ionic radii and lanthanide contraction, occurrence, separation of lanthanides, Lanthanide compounds.

Actinides: General characteristics of actinides, chemistry of separation of Np, Pu and Am from uranium, Transuranic elements, comparison of properties of Lanthanides and actinides with transition elements.

Section – B (22 periods)

Theory of Qualitative and Quantitative Analysis

Chemistry of analysis of various groups of basic and acidic radicals, chemistry of identification of acid radicals in typical combination, chemistry of interference of acid radicals including their removal in the analysis of basic radicals, common ion effect, solubility product, theory of precipitation, co-precipitation, post precipitation, purification of precipitates.

B. Sc. IInd Year (IVth Semester)
Paper XII (CH-205) Physical Chemistry (Theory)

M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section-A (22 Periods)

Thermodynamics

Second law of thermodynamics, need for the law, different statements of the law, Carnot' s cycles and i ts efficiency, Carnot' s theorm, Thermodynamics scale of temperature. Concept of entropy – entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, entropy as a criteria of spontaneity and equilibrium.

Third law of thermodynamics: Nernst heat theorem, statement of concept of residual entropy, evaluation of absolute entropy fro m heat capacity data. Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, G as criteria for thermodynamic equilibrium and spontaneity, i ts advantage over entropy change. Variation of G with P, V and T.

Section-B (23 Periods)

Electrochemistry

Electrolytic and Galvanic cells – reversible & i rreversible cells, conventional representation of electrochemical cells.

Calculation of thermodynamic quantities of cell reaction (▲G, ▲H & K).

Types of reversible electrodes – metal- metal ion, gas electrode, metal – insoluble salt- anion and redox electrodes. Electrode reactions, Nernst equations, derivation of cell EMF and single electrode potential. Standard Hydrogen electrode, reference electrodes, standard electrode potential, sign conventions, Concentration cells with and without transference, l iquid junction potential and i ts measurement. Applications of EMF measurement in solubility product and potentiometric t i trations using glass electrode. More stress on numerical problems.

B. Sc. IInd Year (IVth Semester) Paper-XIII (CH-206) Organic Chemistry (Theory)

M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section- A (22 Periods)

Infrared (IR) absorption spectroscopy

Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. Applications of IR spectroscopy in structure elucidation of simple organic compounds.

Amines

Structure and nomenclature of amines, physical properties. Separation of a mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles, reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction.

Electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid.

Section- B (23 Periods)

Diazonium Salts

Mechanism of diazotisation, structure of benzene diazonium chloride, Replacement of diazo group by H, OH, F, Cl, Br, I, NO_2 and CN groups, reduction of diazonium salts to hyrazines, coupling reaction and its synthetic application.

Aldehydes and Ketones

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, advantage of oxidation of alcohols with chromium trioxide (Sarett reagent) pyridinium chlorochromate (PCC) and pyridinium dichromate. Physical properties, Comparison of reactivities of aldehydes and ketones. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction.Oxidation of aldehydes, Baeyer–Villiger oxidation of ketones, Cannizzaro reaction. MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions.

B.Sc. II Year
Paper XIV (CH-207) Practicals

M.Marks:60 **Time: 7 Hrs.**

(One day in two sessions i.e. 9:00AM-12:30PM and 1:30PM-5:00PM)

Section–A (Inorganic)

1. Gravimetric Analysis:

Quantitative estimations of, Cu^{2+} as copper thiocyanate, Ni^{2+} as Ni – dimethylglyoxime and Al^{3+} as oxinate.

2. Colorimetry:

To verify Beer - Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given $KMnO_4/K_2Cr_2O_7$ solution.

3. **Preparations:** Preparation of Cuprous chloride, tetra ammine cupric sulphate, chrome alum, potassium trioxalatochromate(III) and Nickel Hexammine chloride.

Section-B (Physical)

1. To determine the CST of phenol – water system.
2. To determine the solubility of benzoic acid at various temperatures and to determine the ▲H of the dissolution process.
3. . To determine the enthalpy of neutralisation of a weak acid/ weak base vs. strong base/ strong acid and determine the enthalpy of ionisation of the weak acid/ weak base.
4. To determine the enthalpy of solution of solid calcium chloride.
5. To study the distribution of iodine between CCl_4 and water.
6. Determine rate constant of hydrolysis of $CH_3COOC_2H_5$.

Section-C (Organic)

Systematic identification (detection of extra elements, functional groups, determination of melting point or boiling point and preparation of at least one pure solid derivative) of the following simple mono and bifunctional organic compounds: Naphthalene, anthracene, acenaphthene, benzyl chloride, *p* - dichlorobenzene, *m* - dinitrobenzene , *p* - nitrotoluene, resorcinol , hydroquinone, α- naphthol, β - naphthol, benzophenone, ethyl methyl ketone, benzaldehyde, vanillin, oxalic acid, succinic acid, benzoic acid, salicyclic acid, aspirin, phthalic acid, cinnamic acid, benzamide, urea, acetanilide, benzanilide, aniline hydrochloride, p- toluidine, phenyl salicylate (salol), glucose, f ructose, sucrose, *o*-, *m*-, *p* - nitroanilines, thiourea.

Distribution of marks

1.	Section A	15 marks
2.	Section B	15 marks
3.	Section C	15 marks
4.	Viva- voce	05 marks
5.	Lab Record	10 marks

B. Sc. III Year (Vth Semester)
Paper-XV (CH-301) Inorganic Chemistry (Theory)

M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section – A (22 periods)

Metal- Ligand Bonding in Transition Metal complexes

Limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planer complexes, factors affecting the crystal field parameters.

Thermodynamics and Kinetic Aspects of metal complexes

A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, Irving William Series, substitution reactions of square planer complexes of Pt[II], Trans effect.

Section – B (23 periods)

Magnetic properties of Transition metal complexes

Types of magnetic materials, magnetic susceptibility, method of determining magnetic susceptibility, spin only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

Electronic spectra of Transition metal complexes

Selection rules for d-d transition, spectroscopic ground states, spectrochemical series, orgel energy level diagram for d^1 and d^9 states, discussion of electronic spectrum of $[Ti(H_2O)_6]^{+3}$ complex ion.

B. Sc. III Year (Vth Semester)
Paper-XVI (CH-302) Physical Chemistry (Theory)
M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section- A (22 Periods)

Quantum Mechanics-I
Black- body radiation, Plank' s radiation law, photoelectric effect, postulates of quantum mechanics, quantum mechanical operators, commutation relations, Hamiltonian operator, Hermitian operator, average value of square of Hermitian as a positive quantity, Role of operators in quantum mechanics, To show quantum mechanically that position and momentum cannot be predicated simultaneously, Determination of wave function & energy of a particle in one dimensional box.

Physical Properties and Molecular Structure
Optical activity, polarization – (Clausius – Mossotti equation- derivation excluded) . Orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment- temperature method and refractivity method, dipole moment and structure of molecules, Magnetic permeability, magnetic susceptibility and i ts determination. Application of magnetic susceptibility, magnetic properties – paramagnetism, diamagnetism and ferromagnetism.

Section-B (23 Periods)

Spectroscopy
Introduction: Electromagnetic radiation, regions of spectrum, basic features of spectroscopy, statement of Born- oppenheimer approximation, Degrees of freedom.

Rotational Spectrum

Selection rules, Energy levels of rigid rotator (semi-classical principles), rotational spectra of diatomic molecules , spectral intensity distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length and isotopic effect .

Vibrational spectrum

Selection rules, Energy levels of simple harmonic oscillator, pure vibrational spectrum of diatomic molecules, determination of force constant and qualitative relation of force constant and bond energy, idea of vibrational frequencies of different functional groups.

Raman Spectrum

Concept of polarizibility, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules, Quantum theory of Raman spectra.

Give more stress on numerical problems of all spectroscopy.

B. Sc. IIIrd Year (Vth Semester) Paper-XVII (CH-303) Organic Chemistry (Theory)

M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section- A (22 Periods)

NMR Spectroscopy

Principle of nuclear magnetic resonance, the PMR spectrum, number of signals, peak areas, equivalent and nonequivalent protons positions of signals and chemical shift, shielding and deshielding of protons, proton counting, splitting of signals and coupling constants, magnetic equivalence of protons. Discussion of PMR spectra of the molecules: ethyl bromide, n- propyl bromide, isopropyl bromide, 1 , 1 - dibromoethane, ethanol, acetaldehyde, ethyl acetate, toluene, benzaldehyde and acetophenone.. Simple problems on PMR spectroscopy for structure determination of organic compounds.

Section– B (23 Periods)

Carbohydrates

Classification and nomenclature of Monosaccharides, mechanism of osazone formation, interconversion 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, Determination of ring size of glucose and fructose. Open chain and cyclic structure of D(+)- glucose & D(-) fructose. Mechanism of mutarotation.

Structures of ribose and deoxyribose.

An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

Organometallic Compounds

Organomagnesium compounds: the Grignard reagents- formation, structure and chemical reactions.

Organozinc compounds: formation and chemical reactions.

Organolithium compounds: formation and chemical reactions.

B. Sc. III Year (VIth Semester)
Paper-XVIII (CH-304) Inorganic Chemistry (Theory)
M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section – A (22 periods)

Acids and Bases

Arrhenius, Bronsted-lowry, Lux-flood, solvent system and Lewis concept of acids and bases, relative strength of acids and bases, levelling solvents, hard and soft acids and bases(HSAB), Applications of HSAB principle.

Organometallic chemistry

Definition, classification and nomenclature of organometallic compounds, preparation, properties and bonding of alkyls of Li, Al, Hg and Sn, concept of hapticity of organic ligand, Structure and bonding in metal-ethylenic complexes, Structure of Ferrocene, classification in metal carbonyls, preparation, properties and bonding in mononuclear carbonyls.

Section – B (23 periods)

Bio inorganic chemistry

Metal ions present in biological system, classification on the basis of action (essential, non essential, trace, toxic), Metalloporphyrins with special reference to haemoglobin and myoglobin. Biological role of Na^{+}, K^{+}, Ca^{+2}, Mg^{+2}, Fe^{+2} ions, Cooperative effect, Bohr effect.

Silicones and Phosphazenes

Nomenclature, classification, prepration and uses of silicones, elastomers, polysiloxane copolymers, poly phosphazenes and bonding in triphosphazene.

B. Sc. IIInd Year (VIth Semester) Paper-XIX (CH-305) Physical Chemistry (Theory)

M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section- A (22 Periods)

Introduction to statistical mechanics

Need for statistical thermodynamics, thermodynamic probability, Maxwell Boltzmann distribution statistics, Born oppenheimer approximation, partition function and its physical significance. Factorization of partition function.

Photochemistry

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grotthus-Drapper law, Stark-Einstein law (law of photochemical equivalence), Jablonski diagram depiciting 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).

Section-B (23 Periods)

Solutions, Dilute Solutions and Colligative Properties

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, Dilute solutions, Raoult's law. Colligative properties: (i) relative lowering of vapour pressure (ii) Elevation in boiling point (iii) depression in freezing point (iv) osmotic pressure. Thermodynamic derivation of relation between amount of solute and elevation in boiling point and depression in freezing point. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Phase Equillibrium

Statement and meaning of the terms – phase, component and degree of freedom, thermodynamic derivation of Gibbs phase rule, phase equilibria of one component system –Example – water system.

Phase equilibria of two component systems solid-liquid equilibria, simple eutectic Example Pb-Ag system, desilverisation of lead.

B. Sc. IIIrd Year (VIth Semester) Paper-XX (CH-306) Organic Chemistry (Theory)

M. Marks: 32 **Time: 3 Hrs.**

Note: Nine questions will be set. **Q. No. 1**, based on whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B** . Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no. 1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 6 marks each.

Section– A (23 Periods)

Organic Synthesis *via* Enolates

Acidity of α- hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate.

Heterocyclic Compounds

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 to condensed five and six- membered heterocycles. Prepration and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of, quinoline and isoquinoline.

Section– B (22 Periods)

Amino Acids, Peptides& Proteins

Classification, of amino acids. Acid- base behavior, isoelectric point and electrophoresis. Preparation of α-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, solid–phase peptide synthesis. Structures of peptides and proteins: Primary & Secondary structure.

Synthetic Poly mers

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.

Natural and synthetic rubbers.

B.Sc. III Year
Paper-XXI (CH-307) Practicals

Max.Marks:60 **Time: 7 Hrs.**

(One day in two sessions i.e. 9:00AM-12:30PM and 1:30PM-5:00PM)

Section– A (Inorganic)

Semimicro qualitative analysis of mixture containing not more than four radicals (excluding interfering, Combinations and insoluables):

Pb^{2+}, Hg^{2+}, Hg_2^{2+}, Ag^{+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH_4^{+}, CO_3^{2-}, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, NO_2^{-}, CH_3COO^{-}, Cl^{-}, Br^{-}, I^{-}, NO_3^{-}, SO_4^{2-}, $C_2O_4^{2-}$, PO_4^{3-}, BO_3^{3-}

Section-B (Physical)

1. To determine the strength of the given acid solution (mono acid only) conductometrically.
2. To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.
3. To determine the strength of given Ferrous ammonium sulphate solution potentiometrically.
4. To determine the molecular weight of a non-volatile solute by Rast method.
5. Prepration of acidic and basic buffers and comparison of their pH with theoretical values.
6. To determine the specific rotation of optically active substance (any two).

Section-C (Organic)

1. Thin Layer Chromatography

(Determination of R_f values and identification of organic Compounds)

Separation of a mixture of coloured organic compounds using common organic solvents.

2. To separate the binary liquid mixtures using distillation.

3. Synthesis of the following organic compounds:

(a) To prepare salicylic acid from Aspirin.
(b) To prepare p-bromoaniline from p-bromoacetanilide.
(c) To prepare m-nitroaniline from m-dinitrobenzene.
(d) To prepare S-Benzyl-iso-thiouronium chloride from Thiourea.

Distribution of marks

1.	Section- A	15 marks
2.	Section- B	15 marks
3.	Section- C	15 marks
4.	Viva- voce	05 marks
5.	Lab Record	10 marks

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