SYLLABUS FOR M.SC. IN CHEMISTRY AND M.SC. INDUSTRIAL CHEMISTRY

For Post Graduation Entrance Test

B. Sc. I
Paper I
Physical Chemistry

1. Mathematical Concepts and Computers

(A) Mathematical Concepts

Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like f(x), e^x, x^n, sin x, log x; maxima and minima, partial differentiation and reciprocity relations. Integration of some useful/relevant functions; permutations and combinations, Factorials and Probability.

(B) Computers

General introduction to computers, different components of a computer, hardware and software, input-output devices; binary numbers and arithmetic; introduction to computer languages. Programming, operating systems.

2. Gaseous States

Postulates of kinetic theory of gases, deviation from ideal behaviour, van der Waals equation of state.

Critical Phenomena : PV isotherms of real gases, continuity of states, the isotherms of van der Waals equation, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of state.

Molecular Velocities : Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquefaction of gases.

3. Liquid State

Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases.

Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic, smectic and cholesteric phases and applications.

4. Solid State

Definition of space lattice and unit cell.

Laws of crystallography:

(i) Law of constancy of interfacial angles
(ii) Law of rationality of indices
(iii) Law of symmetry - Symmetry elements in crystals.

X-ray diffraction: Derivation of Bragg's equation. Determination of crystal structure of NaCl and KCl.

A brief introduction to point defects in crystals, semiconductors, superconductors and nanomaterials (only qualitative idea).

5. Colloidal State and Macromolecules

Definition of colloids and classification of colloids.

Solids in liquids (sols): properties - kinetic, optical 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 applications of colloids.

Macromolecules : Determination of molecular weight of macromolecules by osmotic pressure and viscosity methods. Concepts of micelles and critical micelle concentrations.
A brief introduction to conducting and light emitting polymers.

6. Chemical Kinetics and Catalysis

Rate of a reaction- factors influencing the rate of a reaction such as concentration, temperature, pressure, solvent, light and catalyst. Concentration dependence of rates, mathematical characteristics of simple chemical reactions - zero order, first order, second order, pseudo order, half life and mean life. Determination of the order of reaction - differential method, method of integration, method of half life period and isolation method. Radioactive decay as a first order phenomenon. Experimental methods for the studies of chemical kinetics.

Theories of chemical kinetics: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy, Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects.

Catalysis: Characteristics of catalysed reactions, classification of catalysis, Industrial catalysts and enzyme kinetics.

Books Recommended:

B.Sc. I
Paper II
Inorganic Chemistry

1. Atomic Structure and Periodic Table

Quantum numbers. shapes of s, p and d orbitals. Pauli's exclusion principle. Hund's rule Aufbau principle. Variation of orbital energies with atomic number and energy level diagram. Long form of periodic table based on electronic configuration.

2. Periodic properties of elements :

(i) Types of radii (Covalent, Crystal and Van der Waal)
(ii) Electron affinity and its variation
(iii) Ionisation potential, Factors affecting the magniutude of I.P., Concept of effective nuclear charge and shielding effect (Calculation of Screening constant with Slater's rules.)
(iv) Electronegativity (Pauling, Mulliken and Allred Rochow scale) and its variation.

3. Chemical Bonding :

(i) **Ionic:** Conditions favouring the ionic bond, radius ratio in ionic solids.
Concept of lattice energy and Born-Haber cycle, Polarisation of ions and Fajan's rules.
(ii) **Covalent and brief idea of other bonds:**
Concept of directed valence and hybrid orbital description (sp, sp^2, sp^3, sp^3d and sp^3d^2) using simple illustrations, determination of the shapes of molecules and ions viz. NH_3, H_2O, H_3O^+, SF_4, ClF_3, ICl_2^- and I_3^- by VSEPR concept, Concept of maximum covalency. Odd electron bond, Hydrogen bond, Three centre bond and Metallic bond.

4. General studies of s and p block elements :

Group wise discussion with respect to electronic configuration, ionisation potential, electron affinity, electronegativity, atomic and ionic radii, oxidation states, catenation and inert pair effect (wherever applicable). Trends in their hydrides, oxides and halides.

5. Occurrence, extraction and isolation of Li, Be and F_2

6. (a) Preparation, properties and structures of diborane, borazine, hydrazine, interhalogens and polyhalides and fluorides of xenon.
(b) Structure and basicities of oxyacids of B, P and S.

Books Recommended:

B.Sc.-1
Paper- III
Organic Chemistry

1. **Structure and Reactivity**

Bond orbitals of carbon (sp, sp^2 and sp^3 Hybridization). Polarity of co-valent bonds; types of electronic displacements (Inductive, Electromeric, Resonance and Hyperconjugation); Hydrogen-bonding; Homolysis and Heterolysis; Concept of Carbocation, Carbanion and Free radicals.

2. **Alkenes, Alkynes Alkadienes and cycloalkanes**

(i) Elementary treatment of mechanism of addition of hydrogen, halogens, halogen acids, water and sulphuric acid.
(ii) Hydroboration, epoxidation, ozonolysis and hydroxylation.
(iii) Acetylene as carbon acid (replacement by Na,Cu and Ag).
(iv) Hydration, halogenation, addition of HCl and organic acids.
(v) Stability and addition reactions of 1,3-butadiene.
(vi) General methods of preparation and properties of small ring cycloalkanes. Treatment of optical and geometrical isomerism.

3. **Stereochemistry:**

(i) **Optical isomerism**
  (a) Concept of chirality, elements of symmetry.
  (b) Optical isomerism of compounds containing one (lactic acid) and two asymmetric carbons tartaric acid).
(ii) Methods of racemization and resolution, relative and absolute configuration.
(iii) **Geometrical isomerism:** Maleic and fumaric acid, and methods for their configurations.
(iv) Sawhorse and Newman's projection formula; R-S, D-L and E-Z nomenclatures.
(v) Conformations of ethane and n-butane

4. **Alkyl halides and Grignard's Reagent**

Mechanisms of nucleophilic substitution reactions of alkyl halides. Preparation and synthetic applications of Grignard Reagent.

5. **Alcohols and Ethers**

(a) Classification, distinctions and mechanism of dehydration of primary, secondary and tertiary alcohols.
(b) Isomerism of propanols, butanols and pentanols.
(c) Industrial preparation, reactions and structures of glycerol.
(d) **Ethers:** Williamson's synthesis, formation and cleavage of oxonium salts, elementary idea about crown ethers.

6. **General reactions of carbonyl compounds**

(i) Oxidation-Reduction(Catalytic,$LiAlH_4$,Clemmensen's,Meerwein-Ponndorf-Verley reduction.
(ii) Mechanism of addition of alcohol, sodium bisulphite and HCN.
(iii) Mechanism of Aldol & Cannizzaro reactions, and Wolff-Kishner reduction.

7. Carboxylic acids:

(i) Structure of carboxylic group.
(ii) Acid strength with special reference to formic, acetic, propionic and chloroacetic acids.
(iii) Mechanism of esterification & ester hydrolysis ($\mathbf{B_{Ac}^2}$ and $\mathbf{A_{Ac}^2}$ mechanism.).
(iv) Mechanism of acetylation with Acetic anhydride and acetyl chloride.

8. Example of compounds containing reactive methylene group: Preparation and synthetic uses of acetoacetic ester and malonic esters only, keto-enol tautomerism.

9. Nitrogen containing compounds:

(i) Preparation and distinction between
  (a) alkyl nitrites & nitroalkanes, and
  (b) alkyl cyanides & alkylisocyanides.
(ii) Amines
  (a) Classification, distinction and separation of Primary, Secondary & tertiary amines.
  (b) General methods of preparation and general reactions.
  (c) Relative basicities of methyl, ethyl, dimethyl, diethyl, trimethyl and triethylamines.

10. Numerical questions based on determination of structural formula.

Books Recommended:

B.Sc. I
PRACTICALS

The duration of practical examination will be of six hours and will comprise of the following exercises:

1. General - calibration of thermometer and fractional weights

2 Inorganic Chemistry:

Qualitative analysis of an inorganic mixture containing five radicals out of the following preferably by semi-micro technque (including insoluble substances):-

NH_4^+, Na^+, K^+, Mg^{++}, Ca^{++}, Sr^{++}, Ba^{++}, Zn^{++}, Mn^{++}, Ni^{++}, Co^{++}, Al^{+++}, Fe^{+++}, Cr^{+++}, Cu^{++}, Bi^{++}, Hg^+, Hg^{++}, Cd^{++} As^{+++}, Sb^{+++}, Sn^{++}, Pb^+ ,Pb^{++}, Ag^+. CO_3^{2-},NO_2^-, S^{2-}, SO_3^{2-} ,SO_4^{2-}, F^-, Cl^-, Br^-, NO_3^-, CH_3COO^- , Borate, Oxalate, and Phosphate.

3. Physical Chemistry

1. Determination of molecular weight of sulphur by Rast Method.
2. Kinetics of precipitation of sulphur from sodium thiosulphate by mineral acid.
3. Kinetics of dissolution of Mg-ribbon in HCl.
4. To determine the percentage composition of a given binary mixture (non-interacting systems) by viscosity methods.
5. To determine the percentage composition of a given binary mixture (non - interacting) by surface tension method.

4. Organic Chemistry

(a) Preparation of organic compounds:

1. Acetanilide
2. p-bromoacetanilide
3. picrates

(b) Crystallization and determination of melting point.

1. Phthalic acid from hot water (using fluted filter paper and stemless funnel)
2. Acetanilide from boiling water
3. Naphthalene from ethanol
4. Benzoic acid from water

The distribution of marks will be as follows:

1.	Mixture Analysis (3 marks for each correct radical)	15
2	Organic preparation	10
3.	Crystallization	05
4.	Physical Chemistry	15

5.	Viva Voce	10
6.	Record	10
Total		**65**

Note : The number of candidates to be examined in the practical per batch should not exceed 50. At least one experiment is to be given from each section in the examination.

B.Sc. II
Paper I
Physical Chemistry

1. Thermodynamics – I

Definition of terms: system, surroundings, open system, isolated system, intensive and extensive properties, State and path functions and their differentials, reversible and irreversible processes, Concept of heat and work.
First Law of Thermodynamics :concepts of internal energy and enthalpy, heat capacities at constant volume and constant pressure and their relationship. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for a reversible process.
Thermochemistry : standard state, standard enthalpy of formation- Hess's Law of constant heat summation and its applications, heat of reaction at constant pressure and at constant volume, Bond dissociation energy and its calculation from thermo-chemical data, Kirchhoff's equation.

2. Thermodynamics –II

Second law of thermodynamics: 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 process.
Gibbs and Helmholtz functions; Criteria for thermodynamic equilibrium and spontaneity in term of changes in entropy, Gibbs and Helmholtz functions. Concept of chemical potential.

3. Chemical Equilibrium

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chattelier's principle.

4. Phase Equilibrium

Statement and meaning of the terms - phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system - water, Sulpher and Hellium. First and second order phase transitions.
Phase equilibria of two component systems - solid-liquid equilibria, simple eutectic - Pb-Ag system, desilverisation of lead, Systems involving compound formation with a congruent melting point (Mg-Zn) and an incongruent melting point ($CuSO_4$-H_2O).
Nernst distribution law and its thermodynamic derivation.

5. Electrochemistry – I

Electrical transport - conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution.
Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Activity and activity coefficient.
Transport number, definition and determination by Hittorf method and moving boundary method.

Applications of conductivity measurements: determination of degree of dissociation, determination of K_a of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

6. Electrochemistry – II

Types of reversible electrodes - gas-metal ion, metal-metal ion, metal-insoluble salt-anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode-reference electrodes- standard electrode potential, sign conventions, electrochemical series and its significance.
Electrolytic and Galvanic cells - reversible and irreversible cells, conventional representation of electrochemical cells.
EMF of a cell and its measurements. Computation of cell EMF. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K).
Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations.
Definition of pH and pK_a determination of pH using hydrogen, quinhydrone and glass electrodes, by potentiometric methods.
Buffers - mechanism of buffer action, Henderson-Hazel equation. Hydrolysis of salts.
Electrochemical corrosion and its prevention.

B.Sc. II
Paper-II
Inorganic Chemistry

1. **Concept of electrode potential** : EMF diagrams and their utility.

2. **Transition Elements:** Position in periodic table, electronic configuration, General Characteristics, viz., atomic and ionic radii, variable oxidation states, ability to form complexes, formation of coloured ions, magnetic (μ_{so} and μ_{eff}) and catalytic behaviour. General comparative treatment of 4d and 5d elements with their 3d analogues with respect to ionic radii , oxidation states and magnetic properties.

3. **Coordination Compounds :**

   (i) Definition of ligand : Classification with respect to denticity. (Examples of mono-to hexadentate ligands).

   (ii) Werner's postulates, Sidgwick's effective atomic number concept and limitations, Valence Bond Theory of coordination compounds, Stereochemistry of coordination numbers two, four and six with examples of hybrid orbital participation in the following :
   $[Ag(NH_3)_2]^+$, $[Ag(CN)_2]^-$, $[Ni(CN)_4]^{n-}$ (n=2 and 4), $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$, $[MnO_4]^-$, $[Fe(CN)_6]^{n-}$ (n=3 and 4), $[FeF_6]^{3-}$, $[Fe(H_2O)_6]^{3+}$, $[Fe(C_2O_4)_3]^{3-}$, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Ni(NH_3)_6]^{2+}$, $[PbCl_6]^{2-}$

   (iii) Chelate effect

   (iv) Nomenclature for only mono- and di-nuclear complexes.

   (v) Various types of isomerism, viz., hydrate, ionisation, linkage, polymerization and coordination position. Stereoisomerism in C.N.4 and C.N.6 (only $ML_4L'_2$ and $ML_3L'_3$ complexes).

4. **Non-aqueous solvents:**

   Classification and characteristic properties of solvents. Types of chemical reactions occurring in liquid ammonia and liquid sulphur dioxide.

5. **Acid - Base concept :**
   Lewis concept, Concept and classification of hard and soft acids and bases. Applications of HSAB principle.

B.Sc. II
Paper III
Organic Chemistry

1. **Carbohydrates:** Classification, ring structure and configuration of glucose and fructose. Interconversions in the carbohydrate series (Ruff degradation and Killiani-Fischer synthesis).

2. **Aromatic hydrocarbons:** General methods of preparation, aromaticity and molecular orbital representation of benzene.

3. Mechanism of aromatic electrophilic substitutions (nitration, halogenation, sulphonation, alkylation and acylation). Orientation in aromatic substitution and ortho/para ratio.

4. **Aromatic Halogen Compounds:** Different types of halogen compounds, study of chlorobenzene and benzylchloride.

5. **Aromatic nitro compounds:** Nitrobenzene, dinitrobenzene and trinitrotoluene(TNT), reduction of nitrobenzene.

6. **Aromatic amino compounds and diazonium salts:** Study of aniline, benzylamine and toluidines (o, m, & p). Relative basicity of aniline, toluidines. Preparation, reactions and structure of benzenediazonium chloride.

7. **Aromatic sulphonic acids:** Benzene sulphonic acid, sulphalinic acid, chloramine-T,and saccharine.

8. **Phenols:** Acid character, reaction of phenol, preparation and uses of picric acid.

9. **Aromatic alcohols, aldehydes and ketones:** Preparation and reactions of benzyl alcohol, benzaldehyde, salicylaldehyde, acetophenone and benzophenone.

10. **Aromatic acids:** Preparation and properties of cinnamic, phthalic and salicylic acids . Acid strength of benzoic, p-toluic, p-nitrobenzoic and p-chlorobenzoic acids.

11. **Polynuclear Hydrocarbons:**
    (i) Non-condensed system : Biphenyl
    (ii) Condensed system: Naphthalene and its derivatives, 1- and 2-naphthols and naphthylamines, tetraline and decaline)
12. **Heterocyclic compounds:** Preparation & reactions of furan, pyrrole, thiophene & pyridine.

13. Numerical problems for the determination of structures based on chemical reactions of above mentioned compounds.

B.Sc. II
PRACTICALS

The duration of practical examination will be of six and a half hours and will comprise of the following exercises:

1. **General -** Calibration of pipettes and burettes, preparation of standard solutions, dilution-0.1 M to 0.001 M solutions.
2. **Inorganic Chemistry**

   Volumetric Exercises :

   (i) Estimation of silver ions by volhard's and Mohr's method.

   (ii) Redox titrations e.g. titration of ferrous ion with permanganate and dichromate using internal and external indicators.

   (iii) Iodometric Estimation of Copper Sulphate and Potassium dichromate.

   (iv) Estimation of Ca^{2+} ions using $KMnO_4$ solutions.

   (v) Determination of acetic acid in commercial vinegar using NaOH.

3. **Physical Chemistry**

   (i) Determination of heat of neutralization of

   (a) Strong acid-strong base

   (b) Strong acid-weak base

   (c) Weak acid - strong base

   (ii) Determination of enthalpy of solution of solid calcium chloride and calculation of lattice energy of $CaCl_2$ by using BORN-HABER cycle.

   (iii) Determination of the transition temperature of the given substance by thermometric method (e.g. $MnCl_2.4H_2O$)

   (iv) To construct the phase diagram of two component system (diphenyl amine + benzophenone) by Thaw-melt method.

4. **Organic Practical**

   Identification of organic compounds containing any one of the following groups:

   aldehyde, carbohydrate, acid, phenol, ketone, ester, alcohol, amine, amide, nitro, hydrocarbon.

   This would include - determination of melting or boiling point, element detection, test for solubility and unsaturation test for functional groups, specific test if any and preparation of suitable derivatives wherever possible.

Each centre is expected to provide sufficient number of organic compounds representing almost all the groups.

Distribution of marks will be as follows :

1.	Inorganic Practical (3 marks for manipulation and 12 marks for result) up to 1.0% of error there is no deduction of marks but after that 1 mark will be deducted for each 0.1% of error)	15 marks.
2.	Physical Chemistry experiment	15 marks.
3.	Organic Practical	15 marks.
4.	Viva-Voce	10 marks.
5.	Record	10 marks.

	Total	***65 marks.***

Note : The number of candidates to be examined in the practical per batch should not exceed 50. At least one experiment is to be given from each section in the examination .

B.Sc. III
Paper– I
Physical Chemistry

1. Elementary Quantum Mechanics

Black-body radiation, Planck's radiation law, photoelectric effect, Compton effect, concept of wave motion.

De Broglie hypothesis, the Heisenberg's uncertainty principle, Difference between classical and auantum mechanism, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function.

Schrodinger wave equation for H-atom, separation into three variables (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions.

Molecular orbital theory, basic ideas - criteria for forming M.O from A.O, construction of M.O's by LCAO - H_2^+ ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions, concept of σ, σ^*, π, π^* orbitals and their characteristics.

Introduction to valence bond model of H_2, comparison of M.O. and V.B. models.

2. Nuclear Chemistry

Fundamental particles and their classification. Nuclear forces. Liquid drop and shell models of atomic nucleus. Nuclear stability. Energy changes in nuclear reactions. Fission, The atom bomb, spallation and fusion reactions, Hydrogen bomb. Concept of nuclear cross–sections. Radioactive equilibrium, kinetics of radioactive decay, Applications of radioactivity- radioactive dating, radioactive tracer technique, radioactivity in medicines, radioactivity in agriculture and research.

3. Statistical/ Molecular Thermodynamics

Energy levels. Microstates. The Boltzmann factor. Partition function. Relation between partition functions and thermodynamic functions. Translational, rotational and vibrational partition function.

4. Spectroscopy

Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom.

Rotational Spectrum

Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules

Spectral intensity :

distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length, qualitative description of non-rigid rotor, isotope effect.

Vibrational Spectrum

Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.

Raman Spectrum: concept of polarizability, condition for Raman active vibrations, mutual exclusion principle pure rotational and pure vibrational Raman spectra of diatomic molecules.

Electronic Spectrum

Concept of potential energy curves for bonding and antibonding molecular orbtials, qualitative description of selection rules and Franck-Condon principle.

Qualitative description of σ, π and n M.O., their energy levels and the respective transitions.

5. Photochemistry

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grotthus - Draper 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).

6. Surface Chemistry

Adsorption, difference between Physical adsorption and chemisorption, Adsorption isotherms - Langmuir adsorption isotherm and Freundlich adsorption isotherm, BET equation, Determination of surface area.

7. Solutions, Dilute Solutions and Colligative Properties

Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties.

Abnormal molar mass, degree of dissociation and association of solutes.

B.Sc. III
Paper-II
Inorganic Chemistry

1. Chemistry of Lanthanides and Actinides

i. Electronic Configuration,
ii. Atomic and Ionic radii,
iii. Ionisation energy ,
iv. Calculation of magnetic moments and correlation with experimental data (specially for lanthanides),
v. Colour and spectral behaviour,
vi. Oxidation states and their stability,
vii. Ability to form complexes and examples of complexes of different coordination numbers.
viii. Occurrence and principle of separation of lanthanides.
ix. Chemistry of separation of Np, Pu and Am from U and
x. One synthesis each of Np to Lr.

2. Coordination Chemistry:

(i). **Crystal field theory** : Definition of Crystal field, d-orbital splitting in octahedral, tetrahedral and square planar fields, Explanation of weak and strong field ligands, Dq and factors influencing its magnitude, Calculation of crystal field stabilisation energy for d^1-d^9 weak and strong field complexes. Interpretation of magnetic properties on the basis of crystal field theory.

(ii). **Electronic spectra of transition metal complexes** :Types of electronic transitions, Selection rules for d-d transitions, Charge-transfer, Spectroscopic ground terms for d^1 to d^{10} systems. Spectrochemical series, Discussion of the electronic spectra of only $[Ti(H_2O)_6]^{3+}$ and $[Cu(H_2O)_6]^{2+}$

3. (a) Metal Carbonyls : Ligand behaviour of CO,General methods of preparation, Representation of structures of the binary carbonyls of all nuclearities of V, Cr, Mn, Fe, Co and Ni.

(b) Metal Nitrosyls : Ligand behaviour of NO (NO^+, NO^- and bridging NO), preparation and structures of nitrosyls of Cr, Fe and Ru; carbonyl nitrosyls and cyano nitrosyls

4. Environmental Chemistry

The earth's atmosphere and its components, Types of pollutants and their sources. Green house effect and global warming. Acid rains, Ozone layer (Importance and its protection)

B.Sc. III
Paper –III
Organic Chemistry

1. **Reaction intermediates**: Generation, structure, stability and synthetic applications of carbenes, nitrene, benzyne, carbocations (classical and non classical), carbanions and free radicals.

2. Treatment of E1, E2 and $E1_{CB}$ mechanisms. Labelling experiments to distinguish E2 and $E1_{CB}$ mechanism.

3. **Molecular rearrangements and name reactions**: Pinacol-pinacolone, Benzil-benzilic acid, Beckmann, Fries rearrangements, Claisen-Smith and Dieckmann's reactions.

4. **Polymers**: Types and mechanism of polymerisation, stereocontrol polymerisation. Preparation and uses of Teflon, Terylene, Nylons and Dynel. Natural and Synthetic rubbers.

5. **Dyes:** Colour and constitution (electronic concept), Classification of dyes, Chemistry and synthesis of methylorange, Congo red, Malachite green, Crystal violet, Phenolphthalein and fluorescene.

6. **Polynuclear hydrocarbons**: Chemistry of Anthracene and Phenanthrene. A general idea about carcinogenic hydrocarbons.

7. **Heterocycles**: Chemistry of quinoline, isoquinoline and indole.

8. **Amino acids, peptides and proteins:**
    a. Classification, synthesis and properties of amino acids (acid-base behaviour, isoelectric point and electrophoresis).
    b. Synthesis of polypeptides and methods of determining their structure (end group analysis and selective hydrolysis of peptides).
    c. Classification, properties and Structure (primary, secondary and tertiary) of proteins. Protein denaturation/renaturation.

B.Sc. III
Paper IV
Analytical and Biological Chemistry

Section A
Analytical Chemistry

1. **Errors and Evaluation**
   Definition of terms mean and median, precision, standard deviation, relative standard deviation, accuracy, absolute error, types of error in experimental data, determinate (systematic), indeterminate (or random) and gross, sources of errors and effects upon the analytical results, methods for reporting analytical data, statistical evaluation of data, indeterminate errors, uses of statistics.

2. **Volumetric analysis**
   General principles of acid – base titration, precipitation titration, oxidation-reduction titration, iodimetry and iodometry, complexometric titrations, use of EDTA for the determination of Ca^{2+} and Mg^{2+} and hardness of water, types of EDTA titrations, metal ion indicators.

3. **Gravimetric analysis**
   Precipitation from homogeneous medium, purity of precipitates, co-precipitation, post-precipitation, washing and ignition of precipitates, contamination and their removal.

4. **Separation techniques**
   Principle, technique and aanalytical applications of the following:

   (a). Solvent extraction
   (b). Chromatography (Paper, Thin Layer, Column and HPLC)
   (c). Ion exchange

Books

1. Fundamentals of Analytical Chemistry, DA Skoog, DM West FJ Holler, and WB Sauders.
2. Quantitative Inorganic Analysis, AI Vogel.
3. Instrumental Methods of Chemical Analysis, BK Sharma.
4. Instrumental Methods of Chemical Analysis, H. Kaur
5. Analytical Chemistry, Gary D Christian

SectionB
Biological Chemistry

1. **Biological Membranes**
   General features of the biological membrane and its fluid mosaic model. Diffusion, facilitated diffusion aand active transport through a biological membrane, Donnan membrane equilibria.

2. **Nucleic acids**

A general description of constituents of DNA and RNA, Salient features of structures of DNA and RNA, DNA denaturation and renaturation, Effect of UV radiation on DNA. Elementary idea of genetic code and recombinant DNA technology.

3. Enzymes and Coenzymes

General features of enzymes and their active sites, Ribozymes and Abzymes, Enzyme nomenclature, units of enzyme activity, Derivation of Michaelis–Menten equation, Experimental determination and physical significance of K_m and ν_{max} ,significance of k_{cat}/K_m in enzymatic catalysis, Brief description of competitive, uncompetitive, non–competitive and suicidal inhibitors of enzymes. A brief description of coenzymes and function of thiamine pyrophosphate.

4. Role of Metals in Biological systems

(a). Fe in myoglobin and hemoglobin
(b). Cu in plastocyanin and hemocyanin
(c). Zn in carboxypeptidase and carbonic anhydrase
(d). Mg in chlorophyll

Books

1. Outlines of Biochemistry by E. E. Conn and P. K. Stumpf, Wiley Eastern Ltd. New Delhi.
2. Biochemistry by Lubert Stryer , Freeman and company New York (Indian print also available) CBS Publishers and Distributors, Delhi)
3. Biochemistry by Lehninger, Nelson and Cox, Worth Publishers Inc.U.S.A., Indian Print CBS publishers and Distributors, Delhi)
4. Bio inorganic chemistry by Bertini, Gray, Lipard and Valentene, Viva Books Pvt. Ltd. New Delhi.

Note: Question No. 1 is compulsory and it would be of 10 marks. It contains **Six** short answer questions (three from each section) out of which only **Five** should be answered. A total of **Eight** questions (**Four** from each section) will be asked out of which four questions may be attempted with the condition that a maximum of only two questions may be answered from each section

B.Sc. III
PRACTICAL

The duration of practical examination will be of eight hours in one day. The total number of marks will be 100. Each candidate will have to carry out one experiment, from each section.

Section A

Estimate the following metals gravimetrically

1. Barium as Barium sulphate
2. Zinc as Zinc Oxide
3. Iron as Iron Oxide
4. Chromium as Chromium Oxide
5. Lead as lead sulphate
6. Nickel as bis (dimethylglyoximato) nickel (II)

Section B

1. To study the kinetics of reaction between acetone and iodine.
2. To determine the velocity constant for the hydrolysis of methyl acetate catalyzed by hydrogen ions.
3. To determine the solubility of simple salt by evaporation method and to draw the solubility curve.
4. To determine the solubility of benzoic acid by titration method.
5. To determination of amino acid by paper chromatography and thin layer chromatography.

Section C

1. Separation of two component organic mixture (Water separable). Systematic analysis of each component leading to their final identification laying emphasis on solubility, element detection, melting points. Boiling point determination, ignition test, and unsaturation and functional group test and preparation of suitable derivatives.

2. Preparation of the following compounds :
    a. Soap from line seed oil or mahua oil or neem oil or coconut oil.
    b. Phenyl benzoate from phenol
    c. Aspirin from salicylic acid
    d. Picric acid from phenol.
    e. Oxalic acid from cane sugar.
    f. Benzoic Acid from ethyl or methyl benzene.

Distribution of marks will be as follows:

1.	Section	25 marks
2.	Section B	25 marks.
3.	Section C	25 marks
5.	Viva Voce	15 marks.
6.	Record	10 marks.
	Total	**100 marks.**

Note: The number of candidates to be examined in the practical per batch should not exceed 50.

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