B.Sc. Part -I (Physics)

Paper I –Mechanics and wave Motion

Unit -I

Inertial reference frame, Newton's laws of motion, Dynamics of particle in rectilinear and circular motion, Conservative and Non –conservative forces, Conservation of energy, liner momentum and angular momentum, Collision in one and two dimensions, cross section .

Unit -II

Rotational energy and rotational inertia for simple bodies, the combined translation and rotational and motion of a rigid body on horizontal and inclined planes, Simple treatment of the motions of a top. Relations between elastic constants, bending of Beams and Torsion of Cylinder.

Unit -III

Central forces, Two particle central forces problem, reduced mass, reduced mass, relative and centre of mass motion, Law of gravitation, Kepler's laws, Motions of planets and satellites, geo-stationary satellites.

Unit -IV

Simple harmonic motion, differential equation of S. H. M. and its solution, uses of complex notation, damped and forced vibrations, composition of simple harmonic motion.

Differential equation of wave motion, plane progressive waves in fluid media, reflection of waves ,phase change on reflection , superposition , stationary waves ,pressure and energy distribution , phase and group velocity.

Paper II -Circuit fundamentals and basic electronics

Unit-I

Growth and decay of currents through inductive resistances ,charging and discharging in R.C. and R.L.C. circuits , Time constant , Measurement of high resistance.

Alternating currents in R.L.C. circuits, complex impedances, phase diagrams, Q factor, series and parallel resonant circuits, theory of coupled circuits, Transformers, Reflected Impedance and impedance matching.

A.C. Bridges, Maxwell's and Scherings Bridges , Wien Bridge .

Unit -II

Semiconductors, Intrinsic and extrinsic semiconductors, n-type and p-type semiconductors, Unbiased diode Forbard bias and Reverse bias diodes , Diode as a rectifier , diode characteristics ,Zener diode , Avalanche and Zener Breakdown , Power supplies ; rectifier , Bridge rectifier , capacitor input filter , Voltage regulation , Zener Regulator.

Bipolar transistors, three doped regions, forward and reverse bias , DC alpha , DC beta transistor curves.

Unit –III

Transistor biasing circuits: base bias , emitter bias and voltage divider bias, DC load line .

Basic AC equivalent circuits , Low frequency model ,small singal amplifiers , common emitter amplifier, common collector amplifers ,and common base amplifiers , Current and Vottage gain , R.C. coupled amplifer Qualitative treatment only , Frequency response.

Unit-IV

Feedback in amplifiers Input and Output impedance of negative feedback amplifiers, Transistor as an Oscillator, General discussion and theory of Hartley oscillator only.

Elements of transmission and reception, Basic Principles of amplitude modulation and demodulation. Principle and design of linear multimeters and their application, Cathode ray Oscilloscope and its simple applications.

Paper III – Optics

Unit-I

Coherence and Interference of light , Biprism , Thin films , Newton's Rings , Michelson's and Fabry Perot interferometers , Lummer Plate , Multiple beam interference , filters.

Unit-II

Fresnels diffraction, Fresnel's zones and propagation of light , Zone plate , Fresnel's diffraction at straightedge and narrow wire , Fraunhofer diffraction at multiple slits , limiting cases – single and double slits.

Unit-III

Resolving power – criterion, expressions for resolving powers of telescope, grating.
Polarization, Double refraction in uniaxial crystals, Nicol prism, polaroids and retardation plates, Babinet's compensator. Analysis of polarised light.

Unit-IV

Optical activity and Fresnel's explanation, Half shade and Biquartz polarimeters .
Matrixr representation of plane polarized waves, matrices for polarizers, retardation plates and rotators, Application to simple systems.

B.Sc. Part - II (Physics)

Paper I – Electricity, Magnetism

Electrostatics

Coulomb's law, Electric Field and potentials, Field due to a uniform charged sphere, Derivations of Poisson and Laplace Equations, Gauss Law and its application: The Field of a conductor . Electric dipole, Field and potential due to an electric dipole, Dipole approximation for an arbitrary charged distribution, Electric quadruple, Field due to a quadruple , Electrostatic Energy of a charged uniform sphere , Energy of a condenser .

Unit -II

Magnetostatics

Magnetic field , Magnetic force on a current , Magnetic Induction and Bio – Savart Law , Lorentz Force , Vector and Scalar Magnetic potentials , Magnetic Dipole , Magnetomotive force and Ampere's Circuital theorem and its applications to calculate magnetic field due to wire carrying current and solenoid .

Unit –III

Electromagnetic Induction

Laws of Induction, Faraday's laws and Lanz's Law. Mutual and Self Induction , Vector potential in varying Magnetic field , Induction of current in continuous media , Skin effect , Motion of Electron in changing magnetic field , Betatron , Magnetic energy in field , Induced magnetic field (Time varying electric field) ,Displacement current , Maxwell's equations, Electromagnetic waves in free space , Poynting Vector , Theory and working of moving coil ballistic galvanometer .

Unit –IV

Dielectrics

Dielectric constant, polarication , Electronic polarization , Atomic or ionic Polarisation , Polarisation charges , Electrostatic equation with dielectrics , Field , force and energy in Dielectrics .

Magnetisation Properties of Matter

Intensity of magnetization and magnetic susceptibility, Properties of Dia , Para nd Ferromagnertic materials , Curie temperature , Hysteresis and its experimental determination.

Paper II – Thermal Physics

Unit – I

Thermal equilibrium, Zeroth law of thermodynamics, Temperature concept, Equations of State, Van der Waal's equation, Critical constants, principle of corresponding states.

Unit –II

First law of thermodyanamics , Absolute scale of temperature Entropy , Degradation of energy , Enthalpy Helmholtz function , Gibbs function , Maxwell's thermodynamics relations and their application.

Unit –III

Differential and Integral Joule Thomson effect, Inversion temperature, Liquification of gasses (no Experimental details). Adiabatic demagnetization, He I and II. Clausius Clapeyron equation.

Unit – IV

Kinetic theory, Maxwell – Boltzmann law, Equipartion of energy, Mean free path, transport phenomena, Brownian motion Avogadro number.

Thermodynamic and Kinetic temperature, Blackbody radiation, Stefan Boltzmann's law , Plsnck's law and its verification .

Paper III – Elements of Quantum Mechanics and Atomic Spectra.

Unit –I

Inadequacies of classical mechanics , Photoelectric phinomena , Compton effect , Wave-particle duality , de Briglie matter waves and their experimental verification , Heisenberg's Uncertainty principle , Complementary principle , Principle of superposition , Motion of wave packets .

Unit –II

Schr'odinger wave equation , Interpretation of wave function , Expectation values of dynamical variables , Ehrenfest theorem , Orthonormal properties of wave functions , One diomensional motion in step potential , Rectangular barrier , Square well potential , Particle in a box normalization .

Unit –III

Bohratomic model, Sommerfeld elliptic orbits, Spin and orbital magnetic moments, Stern – Gerlach experiment, Pauli's exclosion principle and periodic table. Optical spectra of alkali and alkaline earth elements, Fine structure of spectral lines, Coupling schemes (LS and JJ) for two electron systems.

Unit -IV

Normal and anomalous Zeeman Effect and Paschen Back effect of one electron systems, Experimental observation, X-ray spectra – continuous and characteristic, their generation and uses, Spin and screening doublets.

Books Recommended:

1. A Beiser- Concept of Modern Physics, McGraw-Hill, New York.
2. R.M. Eisberg – fundamentals of Modern Physics, Wiley, New York.
3. H.E. White – Introduction to Atomic Spectra, McGraw-Hill, New York.

B.Sc. – III (Physics)

Paper – I Elements of Relativistic, Classical & Statistical Mechanics:

Unit – I

Relativistic Mechanics:

Earth as a reference frame, Galilean transformation, Michelson-Morley experiment, postulates of special theory of relativity, Lorentz transformations, Lorentz contraction and time dilation, Law of addition of velocities, variation of mass with velocity, Principle of equivalence of mass and energy.

Unit – II

Classical Mechanics:

Mechanics of a system of particles, generalized co-ordinates, D'Alembert's principle. The Lagrangian formulation and Lagrange's equations of motion. Calculus of variation and it's applications. The Hamiltonian formulation and Hamilton's equation of Motion.

Unit – III

Classical Mechanics & Statistical Mechanics:

The rigid body motion, Force-free motion of symmetrical rigid body. Two – body central force problem, reduction to equivalent one-body problem, the equation on motion and first integrals, Classification of orbits, Orbit for integrable power-law potentials, Inverse square law-Kepler problem. Inadequacy of Classical Mechanics, phase space, Liouville's theorem, connection between statistical and thermodynamic quantities.

Unit – IV

Statistical Mechanics:

Ensembles, the microcanonical, the canonical and grand canonical ensembles, Maxwell-Boltzmann statistics, Partition function, Maxwell Velocity distribution and mean values, equipartition theorem, Statistics of interacting systems, Van der Waal's gas, Statistics of identical particles, Fermi-Dirac and Bose-Einstein Statistics, simple applications, electron gas and Planck's oscillator.

Paper – II – Solid State and Nuclear Physics:

Unit – I

Crystal Structure:

Lattice translation vectors and lattice, Symmetry operations, Basis and crystal structure, Primitive Lattice cell, Two-dimensional lattice type, systems, Number of lattices, Point groups and plane groups, Three dimensional lattice types, System, Number of Lattices, Points groups and space groups, Index system for crystal planes-Miller indices, Simple crystal structures, NaCI, hep, diamond, Cubic ZnS and hexagonal ZnS, Occurrence of Nonideal crysal structures, random stacking of polytyprism, glasses.

Crystal Diffraction and Reciprocal Lattice:

Incident beam, Bragg law, Experimental diffraction method, Laue method, Rotating-crystal method, Powder method Derivation of scattered wave amplitude, Fourier analysis, Reciprocal lattice vectors, Diffraction conditions, Ewald

method, Brillouin zones, Reciprocal lattice to sc, bcc and fcc lattices, Fourier analysis os the basis and atomic form factor.

Unit – II

Crystal Bindings:

Crystal of inert gases, Van der Walls-London interaction repulsive interaction, Equilibrium lattice constants, Cohesive energy, compressibility and bulk modulus, Lonic crystal, Madelung energy evaluation of Madelung constant, Covalent crystals, Hydrogen-bonded crystals, Atomic radii.

Lattice Vibrations:

Lattice Heat capacity, Einstein model, Vibrations of monatomic lattice, derivation of dispersion relation, First brillouin zone, group velocity, continuum limit, Force constants, Lattice with two atoms per primitive cell, derivation of dispersion relation, Acoustic and optical modes, Phonon momentum.

Free electron theory, Fermi energy, density of states, Heat capacity of electron gas, Paramagnetic susceptibility of conduction electrons Hall effect in metals.

Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Number of orbitals in a band, conductor, Semi-conductor and insulators, Effective mass, Concept of holes.

Unit – III

Nuclear Physics:

1. **General Properties of Nucleus:**
   Brief survey of general Properties of the Nucleus, Mass defect and binding energy, charges, Size, Spin and Magnetic moment, Bainbridge mass spectrograph.

2. **Nuclear Forces:**
   Saturation phenomena and Exchange forces, Deutron ground state properties.

3. **Nuclear Models:**
   Liquid drop model and bethe Weiszacher mass formula, Sungle particle shell model (only the level scheme in the context of reproduction of magic numbers).

4. **Natural Radioactivity:**
   Fundamental laws of radioactivity, Soddy-fajan's displacement law and law of radioactive disintegration, Basic ideas about $\alpha, \beta \, and \, \gamma$ decay.

Unit – IV

1. **Nuclear Reactions:**
   Nuclear reactions and their conservation laws, Cross section of nuclear reactions, Theory of fission (Qualitative), Nuclear reactors and Nuclear fusion.

2. **Accelerators and detectors:**
   Vande Graff, Cyclotron and Synchrotron, Interaction of charged particles and gamma rays with matter (qualitative), GM counter, Scintillation counter and neutron detectors.

3. **Elementary Particles:**
   Basic classification based on rest mass, Spin and half life, particle interactions (gravitational, Electromagnetic, week and strong Interactions).

Paper – III – Electronics:

Unit – I

Network Theorems and Circuit Analysis:

Thevenin, Norton and superposition theorems and their applications, T and // Network characteristics Interactive and image impedances, Constant K and derived-m type filters, transmission lines Characteristics impedances and attenuations Reflection coefficients.

Diodes:

Diffusion of minority carrier in semiconductor, work function in metals and semiconductors Junctions between metal and semiconductors, Semiconductor and semiconductor, p.n. Junction, Depletion layer, Junction Potential Width of depletion layer, Field and Capacitance of depletion layer, Forward A.c. And D.C. resistance of junction Reverse Breakdown.

UNIT – II

Diode:

Zener and Avalanche diodes, Tunnel diodes, Point contact diode, their importance at High frequencies, LED photodiodes, Effect of temperature on Junction diode Thermistors.

Transistors:

Transistors parameters, base width modulation transit time and life-time of minority carriers base Emitter resestance Collector conductance, Base spreading resistance, Difusion capacitance, Reverse feedback ratio, Equivalent circuit for transistors, Basic Model, hybrid model and Y parameter equivalent circuit Input and output impedances.

UNIT – III

Current and Voltage gain, Biasing formulae for transistors, Base bias, emitter bias and mixed type bias and mixed type biasing for small and large signal operation.

Transistor circuit application at law frequencies, their AC and DC equivalent for three different modes of operation, Large signal operation of transistors, Transistor Power amplifiers, Class A and B operation, Maximum power output Effect of temperature, heat sinks, thermal resistance Distorsion in amplifiers, cascading of stages, Frequency response, Negative and positive feedback in transistor amplifiers.

UNIT – IV

Field effect transistors and their characteristics biasing of FET, use in preamplifiers MOSFET and their simple uses.

Power Supplies:

Electronically regulated law and high voltage power supplies, Inverters for battery operated equipments.

Miscellaneous:

Basic linear integrated circuits phototransistors, Silicon Controlled rectifiers, Unijunction transistor and their simple uses.

B.Sc. I Paper – I

Inorganic Chemistry

Unit I

I Atomic Structure

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of ψ and ψ^2, quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge

II Periodic Properties

Atomic and ionic radii, ionization energy, electron affinity and electronegativity – definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behaviour.

Unit II

III Chemical Bonding

(A) Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to NH_3, H_3O^+, SF_4, ClF_3, ICl_2^- and H_2O. MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

(B) Ionic Solids – Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic bond-free electron, valence bond and band theories.

(C) Weak Interactions – Hydrogen bonding, van der Waals forces

Unit III

IV s-Block Elements

Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls.

V Chemistry of Noble Gases

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

Unit IV

VI p-Block Elements

Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of groups 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetranitride, basic properties of halogens, interhalogens and polyhalides.

B.Sc. I Paper II

Organic Chemistry

Unit – I

I Structure and Bonding

Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bon, van der Waals interactions, inclusion compounds, clatherates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.

II Mechanism of Organic Reactions

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

Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning format charges on intermediates and other ionic species.

Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

III Alkanes and Cycloalkanes

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atom in alkanes, Isomerism in alkanes, sources methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), 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 strain less rings. The case of cyclopropane ring, banana bonds.

Unit – II

IV Stereochemistry of Organic Compounds

Concept of isomerism. Types of isomerism.

Optical isomerism – elements of symmetry, molecular chirality, enantionmers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and recemization.

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

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; conformations of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae.

Difference between configuration and conformation.

Unit – III

V Alkenes, Cycloalkenes, Dienes and Alkynes

Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes.

Chemical reactions of alkenes – mechanism involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$. Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene.

Methods of formation, conformation and chemical reactions of cycloalkenes.

Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization, Chemical reaction – 1,2 and 1,4 additions, Diets-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 reductions, oxidation and polymerization.

Unit – IV

VI Arenes and Aromaticity

Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: molecular formula and kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture.

Aromaticity: the Huckel rule, aromatic ions.

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 alhylbenzenes, alkynylbenzenes and biphenyl.

VII Alkyl and Aryl Halides

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

Polyhalogen compounds: chloroform, carbon tetrachloride.

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 reactivities of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC.

B.Sc. I Paper 3

Physical Chemistry

Unit I

I Mathematical Concepts and Computers

(A) Mathematical Concepts

Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like k_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. Probability.

(B) Computers

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

Unit II

II Gaseous States

Postulates of kinetic theory of gases, deviation from ideal behavior, 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. Liquification of gases (based on Joule-Thomson effect).

III 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 and cholestric phases. Thermography and seven segment cell.

Unit III

IV Solid State

Definition of space lattice, 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 by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).

V Colloidal State

Definition of colloids, 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.

Unit IV

VI Chemical Kinetics and Catalysis

Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light, 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 of chemical kinetics: conductometric, potentiometric, optical methods, polarimetry and spectrophotometer.

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, miscellaneous examples.

B.Sc. I Practicals

180 Hrs (6 Hrs/week)

Inorganic Chemistry

Semimicro Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI. Anion analysis.

Organic Chemistry

Laboratory techniques

Calibration of Thermometer

80-82° (Naphthalene),113.5-114° (Acetanilide),
132.5-133° (Urea), 100° (Distilled Water)

Determination of melting point

Naphthalene 80 -82°, Benzoic acid 121.5-122°
Urea 132.5-133°, Succinic acid 184.5-185°
Cinnamic acid 132.5-133°, Salicylic acid 157.5-158°
Acetanilide 113.5-114°, m-Dinitrobenzene 90°
p-Dichlorobenzene 52°, Aspirin 135°

Determination of boiling points

Ethanol 78°, Cyclohexane 81.4°, Toluene 110.6°, Benzene 80°

Mixed melting point determination

Urea-Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1)

Distillation

Simple distillation of ethanol-water mixture using water condenser
Distillation of nitrobenzene and aniline using air condenser

Crystallization

Concept of induction of crystallization
Phthalic acid from hot water (using fluted filter paper and stemless funnel)
Acetanilide from boiling water
Naphthalene from ethanol
Benzoic acid from water

Decolorisation and crystallization using charcoal

Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration.
Crystallization and decolorisation of impure naphthalene (100g of naphthalene mixed with 0.3 g of Congo Red using 1g decolorising carbon) from ethanol.

Sublimation (Simple and Vacuum)

Camphor, Naphthalene, Phthalic acid and Succinic acid.

Qualitative Analysis

Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.

PHYSICAL CHEMISTRY

Chemical Kinetics

1. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
2. To study the effect of acid strength on the hydrolysis of an ester.
3. To compare the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of ethyl acetate.
4. To study kinetically the reaction rate of decomposition of iodide by H_2O_2.

Distribution Law

1. To study the distribution of iodine between water and CCl_4.
2. To study the distribution of benzoic acid between benzene and water.

Colloids

1. To prepare arsenious sulphide sol and compare the precipitating power of mono-, bi- and trivalent anions.

Viscosity, Surface Tension

1. To determine the percentage composition of a given mixture (non interacting systems) by viscosity method.
2. To determine the viscosity of amyl alcohol in water at different concentrations and calculate the excess viscosity of these solutions.
3. To determine the percentage composition of a given binary mixture by surface tension method (acetone & ethyl methyl ketone).

B.Sc. II Paper – I

Inorganic Chemistry

Unit - I

I Chemistry of Elements of First Transition Series

Characteristic properties of d-block elements.

Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry.

II Chemistry of Elements of Second and Third Transition series

General characteristics, comparative treatment of Zr/Hf , Nb/Ta , Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

Unit – II

III Coordination Compounds

Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

Unit – III

IV Chemistry of Lanthanide Elements

Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analytical uses.

V Chemistry of Actinides

Electronic conformation, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

Unit IV

VI Oxidation and Reduction

Electrode potential, electrochemical series and its applications. Principles involved in the extraction of the elements.

VII Acids and Bases

Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concept of acids and bases.

VIII Non-aqueous Solvents

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

B.Sc. II Paper – II

Organic Chemistry

Unit I

I. Electromagnetic Spectrum Absorption Spectra:-

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. U.V. spectra of conjugated enes and enones.

Infrared (I.R.) absorption spectroscopy – molecular vibrations, Hooke's law, selection rules, intensity and position of I.R. bands, measurement of I.R. spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of I.R. spectra of simple organic compounds.

Unit II

II. Alcohols:-

Classification and nomenclature.

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 pinacolo-pinacolone rearrangement.

Trihydric alcohols – nomenclature and methods of formation, chemical reactions of glycerol.

III. 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, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

Unit III

IV. Ethers and Epoxides:-

Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method.

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

V. Aldehydes and Ketones:-

Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of alkedydes and ketones using 1,3-dithianes, synthesis of ketones from nitrites and from carboxylic acids. Physical properties.

Mechnism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, 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, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones.

An introduction to α,β unsaturated alkehydes and ketones.

Unit IV

VI. 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: malic, 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.

VII. 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. Mechanisms of esterification and hydrolysis (acidic and basic)

VIII. Organic Compounds of Nitrogen:-

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid.

Halonitroarenes: reactivity, Structure and nomenclature of amines, physical properties. Stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrites), reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

B.Sc. II Paper – III

Physical Chemistry

Unit I
(Thermodynamics & Chemical Equilibrium)

I Thermodynamics – I

Definition of thermodynamic terms:

System, surroundings etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.

First Law of Thermodynamics:

Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law – Joule-Thomson coefficient and inversion temperature. Calculation of w,q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

Thermochemistry:

Standard state, standard enthalpy of formation – Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation.

II Chemical Equilibrium

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

Reaction isotherm and reaction isochore – Clapeyron-clausius equation and its applications.

Unit II

III Thermodynamics – II

Second law of thermodynamic:

Need for the law, different statements of the law. Cornot's cycle and its efficiency, Carnot's theorem. Thermodynamic 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, Clausius inequality, entropy as a criteria of sopntaneity and equilibrium. Equilibrium change in ideal gases and mixing of gases.

Gibbs and Helmholtz functions:

Gibbs function (G) and Helmhotz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G and A with P, V and T.

Third law of thermodynamics:

Nernst heat theorem, statement and concept of residual entropy.

Nernst distribution law – thermodynamic derivation, applications.

Unit III
(Electrochemistry – I & solutions)

IV 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's 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). Transport number, definition and determination by Hittorf's 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.

V Solutions:

Liquid – Liquid mixtures – Ideal liquid mixtures, Raoult's and Henry's law. Non-ideal system-azeotropes –HCl-H_2O and ethanol – water systems.

Partially miscible liquids – Phenol-water, trimethylamine-water, nicotine-water systems. Immiscible liquids, steam distillation.

Unit IV
(Electrochemistry – II & Phase Equilibrium)

VI Electrochemistry – II:

Types of reversible electrodes – gas-metal ion, 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 ($\triangle G$, $\triangle H$ 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.

VII Phase Equilibrium:

Statement and meaning of the terms – phase, component and degree of freedom, derivation of Gibb's phase rule, phase equilibria of one component system – water, CO_2 and S systems.

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

Solid solutions – compound formation with congruent melting point (Mg-Zn) and incongruent melting point, ($FeCl_3$-H_2O) and ($CuSO_4$-H_2O) system

B.Sc. II Practical

Inorganic Chemistry

Calibration of fractional weights, pipettes and burettes. Preparation of standard solutions. Dilution- 0.1 M to 0.001 M solutions.

Quantitative Analysis

Volumetric Analysis

(a) Determination of acetic acid in commercial vinegar using NaOH
(b) Determination of alkali content – antacid tablet using HCl.
(c) Estimation of calcium content in chalk as calcium oxalate by permanganometry.
(d) Estimation of hardness of water by EDTA.
(e) Estimation of ferrous and ferric by dichromate method.
(f) Estimation of copper using thiosulphate.

Gravimetric Analysis

Analysis of Cu as CuSCN and Ni as Ni (dimethylgloxime).

Organic Chemistry

Laboratory Techniques

A. Thin Layer Chromatography

Determination of R_f values and identification of organic compounds.

(a) Separation of green leaf pigments (spinach leaves may be used).
(b) Preparation and separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexan-2- and 3-one using toluene and light petroleum (40:60).
(c) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5).

B. Paper Chromatography: Ascending and Circular

Determination of R_f values and identification of organic compounds.

(a) Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid. Leucine and glutamic acid. Spray reagent – ninhydrin.
(b) Separation of a mixture of D, L – alanine, glycine, and L-Leucine using n-butanol:acetic acid:water (4:1:5). Spray reagent – ninhydrin.

(c) Separation of monosaccharides – a mixture of D-galactose and D – fructose using n-butanol:acetone:water (4:5:1). Spray reagent – aniline hydrogen phthalate.

Qualitative Analysis

Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

Physical Chemistry

Transition Temperature

1. Determination of the transition temperature of the given substance by thermometric/dialometric method (e.g. $MnCl_2.4H_2O/SrBr_2.2H_2O$).

Phase Equilibrium

1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-water system.
2. To construct the phase diagram of two component (e.g. diphenylamine -benzophenone) system by cooling curve method.

Thermochemistry

1. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.
2. To determine the enthalpy of neutralisation of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
3. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born Haber cycle.

B.Sc. III Paper I

Inorganic Chemistry

Unit – I

I Metal-ligand Bonding in Transition Metal Complexes

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

II Thermodynamic and Kinetic Aspects of Metal Complexes

A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes.

Unit – II

III Magnetic Properties of Transition Metal Complexes

Types of magnetic behavior, methods 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.

IV Electronic spectra of Transition Metal Complexes

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

Unit – III

V Organometallic Chemistry

Definition, nomenclature and classification of organometallic compounds.

Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn.

Metal carbonyls: 18 electron rule, preparation, structure and nature of bonding in the mononuclear carbonyls.

VI Silicones and Phosphazenes

Silicons and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.

Unit – IV

VII Hard and Soft Acids and Bases (HSAB)

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.

VIII Bioinorganic Chemistry

Essential and trace elements in biological processes, metalloporphyrins with special reference to hemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+}.

B.Sc. III Paper—II

Organic Chemistry

Unit - I

I **Spectroscopy**

Nuclear magnetic resonance (NMR) spectroscopy,

Proton magnetic resonance (^{1}H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of ^{1}H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone. Problems pertaining to the structures elucidation of simple organic compounds using UV, IR and ^{1}H NMR spectroscopic techniques.

Unit - II

II **Organometallic Compounds**

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

Organozinc compounds: formation and chemical reactions.

Organolithium compounds: formation and chemical reactions.

III **Organosulphur Compounds**

Nomenclature, structural formation, Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides & Sulphaguamidine.

IV **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 reaction in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.

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

Unit - III

V **Carbohydrates**

Classification and nomenclature, 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, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation.

Structures of ribose and deoxyribose.

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

VI **Amino Acids, Peptides, Proteins and Nucleic Acids**

Classification, structure and stereochemistry of amino acids. Acid-base behaviour, Isoelectric point and electrophoresis, Preparation and reactions 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. Levels of protein structure, Protein denaturation/renaturation.

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

Unit - IV

VII **Fats, Oils and Detergents**

Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils, Saponification value, iodine value, acid value, Soaps, synthetic detergents, alkyl and aryl sulphonates.

VIII **Synthetic Polymers**

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 rubborn.

IX **Synthetic Dyes**

Colour and constitution (electronic Concept), Classification of dyes. Chemistry and synthesis of Methyl orange, Conge red, Malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.

X **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.

Alkylation of 1,3-dithianes, Alkylation and acylation of enamines.

B.Sc. III Paper III

Physical Chemistry –

Unit I
(Introductory Quantum Mechanics, Spectroscopy, Physical Properties & Molecular Structure)

I Introductory Quantum Mechanics

Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect. de Broglie's hypothesis, the Heisenberg's uncertainty principle, Hamiltonian operator.

II *Spectroscopy*

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

III Physical Properties and Molecular Structure:

Optical activity, 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 structure of molecules, magnetic properties-paramagnetism, diamagnetism and ferromagnetics.

Unit II

IV Elementary Quantum Mechanics

Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box.

Schrodinger wave equation for H-atom, separation into three equations (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. Hybrid orbitals – sp, sp^2, sp^3; calculation of coefficients of A.O's used in sp and sp^2 hybrid orbitals.

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

Unit III
(Spectsroscopy)

V 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, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

Electronic Spectrum: Concept of potential energy curves for bonding and antibonding molecular orbitals, 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.

Unit IV

(Photochemistry, Solutions, Dilute Solutions and Colligative Properties)

VI Photochemistry:

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus – Drapper 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).

Solutions, Dilute Solutions and Colligative Properties:

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient.

Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental me0thods for determining various colligative properties.

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

B.Sc. III Practicals

180 Hours (12 hours per week)

INORGANIC CHEMISTRY

Synthesis and Analysis

(a) Preparation of sodium trioxalato ferrate (III), $Na_3[Fe(C_2O_4)_3]$ and determination of its composition by permaganometry.

(b) Preparation of Ni-DMG complex, $[Ni(DMG)_2]$.

(c) Preparation of copper tetraammine complex. $[Cu(NH_3)_4]SO_4$.

(d) Preparation of *cis*- and *trans*- bisoxalato diaqua chromate(III) ion.

Instrumentation

Colorimetry

(a) Job's method (b) Mole-ratio method

Adulteration – Food stuffs.

Effluent analysis, water analysis.

Solvent Extraction

Separation and estimation of Mg(II) and Fe(II))

Ion Exchange Method

Separation and estimation of Mg(II) and Zn(II).

ORGANIC CHEMISTRY

Laboratory Techniques

Steam Distillation

Naphthalene from its suspension in water

Clove oil from cloves

Separation of o-and p-nitrophenols

Column Chromatography

Separation of fluorescein and methylene blue

Separation of leaf pigments from spinach leaves

Resolution of racemic mixture of (±) mandelic acid

Qualitative Analysis

Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives.

Synthesis of Organic Compounds

(a) Acetylation of salicylic acid, aniline, glucose and hydroquinone. Benzoylation of aniline and phenol

(b) Aliphatic electrophilic substitution

Preparation of iodoform from ethanol and acetone

(c) Aromatic electrophilic substitution

Nitration

Preparation of m-dinitrobenzene

Preparation of p-nitroacetanilide

Halogenation

Preparation of p-bromoacetanilide

Preparation of 2,4,6-tribromophenol

(d) Diazotizatoin/coupling

Preparation of methyl orange and methyl red

(e) Oxidation

Preparation of benzoic acid from toluene

(f) Reduction

Preparation of aniline from nitrobenzene

Preparation of m-nitroaniline from m-dinitrobenzene.

Stereochemical Study of Organic Compounds via Models

R and S configuration of optical isomers.

E, Z configuration of geometrical isomers.

Conformational analysis of cyclohexanes and substituted cyclohexanes.

PHYSICAL CHEMISTRY

Electrochemistry

(a) To determine the strength of the given acid conductometrically using standard alkali solution.

(b) To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.

(c) To study the saponification of ethyl acetate conductometrically.

(d) To determine the ionisation constant of a weak acid conductometrically.

(e) To titrate potentiometrically the given ferrous ammonium sulphate solution using

$KMnO_4/K_2Cr_2O_7$ as titrant and calculate the redox potential of Fe++/Fe+++ system on the hydrogen scale.

Refractometry, Polarimetry

(a) To verify law of refraction of mixtures (e.g., of glycerol and water) using Abbe's refractometer.

(b) To determine the specific rotation of a given optically active compound.

Molecular Weight Determination

(a) Determination of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.

(b) Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy.

Colorimetry

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

कुलसचिव कार्यालय
लखनऊ विश्वविद्यालय, लखनऊ–226007

संदर्भ संख्या :..... / सम्बद्धता अनु. / 2017

दिनांक :. .....

कार्यालय ज्ञाप

रजिस्टर्ड / स्पीडपोस्ट / व्यक्तिगत

प्राचार्य / प्राचार्या,
लखनऊ विश्वविद्यालय से सहयुक्त समस्त महाविद्यालय,
लखनऊ।

महोदय / महोदया,

सूच्य है कि गणित एवं एस्ट्रोनॉमी विभाग, ल0वि0वि0 द्वारा अवगत कराया गया है कि वर्तमान सत्र 2017–18 से बी0एस–सी0 प्रथम वर्ष के गणित विषय के पाठ्यक्रम (सेलेबस) में संशोधन कर दिया गया है जिसे विश्वविद्यालय की वेबसाईट पर अपलोड कर दिया गया है।

अतः इस सम्बन्ध में कहने का निदेश हुआ है कि बी0एस–सी0 प्रथम वर्ष 2017–18 में संशोधित पाठ्यक्रम के अनुसार अध्ययन / अध्यापन का कार्य कराने का कष्ट करें।

भवदीया,

संलग्नक : उपरोक्तानुसार।

(डॉ0 भावना मिश्रा)
उप कुलसचिव (सम्ब.)

संख्या : AF–4305/1–55 दिनांक : 25/7/17

प्रतिलिपि निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित :–

1. अधिष्ठाता, महाविद्यालय विकास परिषद, ल0वि0वि0।
2. विभागाध्यक्ष, गणित एवं एस्ट्रोनॉमी विभाग, ल0वि0वि0।
3. कुलसचिव जी के अवलोकनार्थ।
4. इंचार्ज, वेबसाईट / कम्प्यूटर केन्द्र, ल0वि0वि0 को इस आशय से प्रेषित कि कृपया समस्त सहयुक्त महाविद्यालयों को संलग्नकों सहित ई–मेल से प्रेषित करने व विश्वविद्यालय की वेबसाईट पर अपलोड करने का कष्ट करें।
5. उप कुलसचिव (प्रवेश), ल0वि0वि0 को संलग्नकों सहित।

Bmishra

(डॉ0 भावना मिश्रा)
उप कुलसचिव (सम्ब.)

Dr. Bhaskar Srivastava
Professor & Head
Department of Mathematics and Astronomy

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UNIVERSITY OF LUCKNOW
LUCKNOW-226007

OFFICE OF THE REGISTRAR * UNIVERSITY OF LUCKNOW * 2252 2 JUL 2017

The Registrar,
Lucknow University

July21, 2017

Dear Sir,

I am herewith sending the new B.A/B.Sc. Part I Mathematics syllabus applicable from July 2017. I request you to kindly intimate all associated colleges, regarding this revised syllabus effective from this session 2017-18.

I have sent an email, on the subject today also.

OS Affiliation
24/7

Yours Faithfully

(Prof. Bhaskar Srivastava)
Head of the Department
Head of Department of
Mathematics and Astronomy
Lucknow University
501/M/17

B.A./B.Sc. I
Mathematics
(For Session 2017-18 and onwards)

Paper I (Differential Calculus)

Unit 1

Definition of a sequence, Theorems on limits of sequences, Bounded and Monotonic sequences, Cauchy's convergence criterion, Cauchy sequence, limit superior and limit inferior of a sequence, subsequence, Series of non-negative terms, convergence and divergence, Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's logarithmic, de Morgan and Bertrand's tests, Alternating series, Leibnitz's theorem, Absolute and conditional convergence.

Unit II

Limit, Continuity and differentiability of function of single variable, Cauchy's definition, Heine's definition, equivalence of definition of Cauchy and Heine, Uniform continuity, Borel's theorem, boundedness theorem, Bolzano's theorem, Intermediate value theorem, Extreme value theorem, Darboux's intermediate value theorem for derivatives, Chain rule, Indeterminate forms.

Unit III

Successive differentiation, Leibnitz theorem, Maclaurin's and Taylor's series, , Rolle's theorem, Lagrange and Cauchy Mean value theorems, Mean value theorems of higher order, Taylor's theorem with various forms of remainders, Partial differentiation, Euler's theorem on homogeneous function.

Unit IV

Tangent and Normals, Asymptotes, Curvature, Envelops and evolutes, Tests for concavity and convexity, Points of inflexion, Multiple points, Tracing of curves in Cartesian and Polar forms.

Paper II (Integral Calculus)

Unit I

Definite integrals as limit of the sum, Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Differentiation under the sign of Integration.

Unit II

Improper integrals, their classification and convergence, Comparison test, μ-test, Abel's test, Dirichlet's test, quotient test, Beta and Gamma functions, properties and convergence

21.7.17

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Unit III

Rectification, Volumes and Surfaces of Solid of revolution, Pappus theorem, Multiple integrals, change of order of double integration, Dirichlet's theorem, Liouville's theorem for multiple integrals

Unit IV

Vector Differentiation, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative, Vector Integration, Theorems of Gauss, Green, Stokes and related problems

Paper III (Matrices & Differential Equations)

Unit I

Types of Matrices, Elementary operations on Matrices, Rank of a Matrix, Echelon form of a Matrix, Normal form of a Matrix, Inverse of a Matrix by elementary operations, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations.

Unit II

Eigen values, Eigen vectors and characteristic equation of a matrix, Caley-Hamilton theorem and its use in finding inverse of a matrix, Complex functions and separation into real and imaginary parts, Exponential and Logarithmic functions Inverse trigonometric and hyperbolic functions,

Unit III

Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear equations.

Unit IV

First order higher degree equations solvable for x, y, p, Clairaut's equation and singular solutions, orthogonal trajectories, Linear differential equation of order greater than one with constant coefficients, Cauchy- Euler form.

PaperIV (Geometry)

Unit I

General equation of second degree, System of conics, Tracing of conics, Confocal conics, Polar equation of conics and its properties.

Unit II

Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimension (Cartesian and vector form).

Unit III

Sphere, Cone and Cylinder.
Reduction of second degree equations.

Unit IV

Central conicoids, Paraboloids, Plane section of conicoids, Generating lines, Confocal conicoids,

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B.Sc. II Year
Paper I (Algebra)

Unit I

Equivalence relations and partitions, Congruence modulo n, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups.

Unit II

Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition, Lagrange's theorem and its consequences, Fermat and Euler theorems

Unit III

Normal subgroups, Quotient groups, Homomorphism and isomorphism, Fundamental theorem of homomorphism, Theorems on isomorphism.

Unit IV

Rings, Subrings, Integral domains and fields, Characteristic of a ring, Ideal and quotient rings, Ring homomorphism, Field of quotient of an integral domain.

Paper II: Mathematical Methods

Unit I

Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables, Schwarz's and Young theorem, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians.

Unit II

Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Convolution theorem, inverse Laplace transforms, Solution of the differential equations using Laplace transforms.

Unit III

Fourier series, Fourier expansion of piecewise monotonic functions, Half and full range expansions, Fourier transforms (finite and infinite), Fourier integral.

Unit IV

Calculus of variations-Variational problems with fixed boundaries- Euler's equation for functionals containing first order derivative and one independent variable, Extremals, Functionals dependent on higher order derivatives, Functionals dependent on more than one independent variable, Variational problems in parametric form.

B.Sc. II Year

Mathematics

Paper III: Differential Equations

Unit I

Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, method of undetermined coefficient, variation of parameters, Series solutions of differential equations, Power series method.

Unit II

Bessel, Legendre and Hypergeometric functions and their properties, recurrence and generating relations.

Unit III

Origin of first order partial differential equations. Partial differential equations of the first order and degree one, Lagrange's solution, Partial differential equation of first order and degree greater than one. Charpit's method of solution, Surfaces Orthogonal to the given system of surfaces.

Unit IV

Origin of second order PDE, Solution of partial differential equations of the second and higher order with constant coefficients, Classification of linear partial differential equations of second order, Solution of second order partial differential equations with variable coefficients, Monge's method of solution.

Paper IV: Mechanics

Unit I

Frame of reference, work energy principle, Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes.

Unit II

Virtual work, Stable and Unstable equilibrium, Catenary, Catenary of uniform strength.

Unit III

Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple Harmonic motion, Motion under other law of forces. Elastic strings, Motion in resisting medium, Constrained motion, Motion on smooth and rough plane curves.

Unit IV

Motion of particles of varying mass, Rocket motion, Central orbit, Kepler's laws of motion,, Motion of particle in three dimensions, Rotating frame of reference, Rotating Earth, Acceleration in terms of different coordinates systems.

B.A./B.Sc. III Mathematics

(For Session 2019-20 and onwards)

Paper I: Analysis

Unit I

Definition and examples of metric spaces, Neighbourhoods, Interior points, Limit points, Open and closed sets, Convergent and Cauchy sequences, Completeness, Cantor's intersection theorem, Series of arbitrary terms, Convergence divergence and oscillation, Uniform convergence of sequences and series of functions, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Power series.

Unit II

Complex numbers as ordered pairs, geometric representation of complex numbers, Stereographic projection, Continuity and Differentiability of complex functions, Analytic functions, Cauchy Riemann equations, Harmonic functions.

Unit III

Complex integration, Cauchy-Goursat theorem, Cauchy's Integral formula, Formulae for first, second and nth derivatives, Cauchy's Inequality, Maximum Moduli theorem, Liouville's Theorem, Elementary functions, Mapping by elementary functions.

Unit IV

Taylor and Laurent Series, Absolute and uniform convergence of Power series, Residues and Poles, Residue theorem, Zeros and Poles of order m, Evaluation of improper real integrals, Improper Integrals and definite integrals involving sines and cosines, conformal mapping.

Reference book : Complex variables and applications by Brown & Churchill

Paper II: Linear & Abstract Algebra

Unit I

Automorphism, inner automorphism, automorphism groups and their computations, Conjugacy relations, Normaliser, Counting principle and the class equation of a finite group, Center of group of prime power order, Sylow's theorems, Sylow's p-subgroup.

Unit II

Prime and maximal ideals, Euclidean Rings, Principal ideal rings, Polynomial Rings, Polynomial over the Rational Field, The Eisenstein Criterion, Polynomial Rings over Commutative Rings, unique factorization domain.

Unit III

Vector spaces, Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Quotient space, Coordinates, Computation concerning subspaces, Linear transformations, The Algebra of linear transformations, rank nullity theorem, their representation as matrices

Unit IV

Linear functionals, Dual space, transpose of a linear transformation, Characteristic values, annihilating polynomials, Cayley Hamilton Theorem, Inner product spaces, Cauchy-Schwarz inequality, orthogonal vectors, Orthogonal complements, Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear, Quadratic and Hermitian forms.

Reference book

1. **Topics in Algebra by I.N. Herstein.**
2. **Linear Algebra by K. Hoffman and R. Kunze.**

Paper III: Numerical Analysis

Unit I

Solution of equations: bisection, Secant, Regula Falsi, Newton Raphson's method, Newton's method for multiple roots, Newton's method for system of two non-linear equations, Interpolation, Lagrange and Hermite interpolation, Difference schemes, Divided differences, Interpolation formula using differences.

Unit II

Numerical differentiation, Numerical Quadrature: Newton Cotes Formulas, Gaussian Quadrature Formulas, System of Linear equations: Direct method for solving systems of linear equations (Gauss elimination, LU Decomposition, Cholesky Decomposition), Iterative methods (Jacobi, Gauss Seidel, Relaxation methods). The Algebraic Eigen value problem: Jacobi's method, Givens method, Power method.

Unit III

Numerical solution of Ordinary differential equations: Euler method, single step methods, Runge-Kutta method, Multi-step methods, Milne-Simpson method, Types of approximation, Least square polynomial approximation, Uniform approximation, Chebyshev polynomial approximation.

Difference Equations and their solutions, Shooting method and Difference equation method for solving Linear second order differential equation with boundary conditions of first, second and third type.

Reference book

1. **Numerical Methods for Engineering and scientific computation by M. K. Jain, S. R. K. Iyengar & R. K. Jain.**
2. **Introductory methods of Numerical Analysis by S. S. Sastry**

Paper IV:Linear Programming

Unit I Linear programming problems, Slack and surplus variables, Standard and matrix forms oflinear programming problem, Basic feasible solution.

Unit II Convex sets, Fundamental theorem of linear programming, Simplex method.

Unit III Artificial variables, Big-M method, Two phase method, Revised simplex method.

Unit IV Duality in linear programming problems, Dual simplex method, Primal-dual method integer programming. Reference book: 1. Linear Programming by G. Hadley