SYLLABUS

BACHELOR OF SCIENCE

PHYSICS CHEMISTRY MATHS

JODHPUR NATIONAL UNIVERSITY

JODHPUR

BACHELOR OF SCIENCE (Physics, Chemistry, Maths)

YEAR 1

Compulsory
Paper I General English
Paper II General Hindi

Physics
Paper III Mechanics
Paper IV Waves & Oscillations
Chemistry
Paper V Inorganic Chemistry
Paper VI Organic Chemistry
Mathematics
Paper VII Algebra & Matrices
Paper VIII Calculus

YEAR 2
Physics
Paper I Thermodynamics and Statistical Physics
Paper II Electronics
Chemistry
Paper III Inorganic Chemistry
Paper IV Organic Chemistry
Mathematics
Paper V Advanced Calculus
Paper VI Differential Equations

YEAR 3
Physics
Paper I Quantum Mechanics and Spectroscopy
Paper II Nuclear Physics
Chemistry
Paper III Inorganic Chemistry
Paper IV Organic Chemistry
Mathematics
Paper V Abstract Algebra
Paper VI Analysis

Paper VII Industry Based Environmental Studies

YEAR 1
PAPER I GENERAL ENGLISH

1. Comprehension and vocabulary
2. Composition
A. Letter/application writing
B. Paragraph writing/ precis writing
C. Report writing
3. Translation
A. Elements of a sentence
B. Transformation of sentence
C. Modals
D. Tense usage
E. Determiners
F. Common errors in English
G. Phrasal verbs

Books recommended
1. A.J. Thomson and : A Practical English Grammar A.V. Martinet (Oxford Paper Back)
2. S.Pit Corder : Intermediate English Practice Book (Orient Longman)
3. Bhaskaran and : Strengthen Your English Hordburgh (OUP 1973)
4. T.l.h. Smith – Pearce : The English Errors Of Indian Students (OUP)
5. I.K. Sharma and : A Practical Course of English (Ramesh Book V.D. Singh Depot, Jaipur)

पेपर 2 सामा य ह द

(अ भाग)

ग एवं प संकलन क व वधवधाएं मशः

1. एक या याओं से स बंधित मशः
2. डॉ॰ प रचया मक पा य पु तक से

(ब भाग)

1. श द शु
2. वा य शु
3. पा रभा षक श दावली (अं `जी श द के ह द समानाथ क श द)
4. सं `पण
5. प लवन

6. वा यांश के लिये साथ क श द
7. ा प
8. श द यु म : अ्भेद
9. निबंध

ग -संकलन

1. ामो थाननानाजी देशमुख ,द नदयाल्शोध सं थानचि कूट
2. पया वरणऔर सनातन छगन मेहता ,सं ंतिऔर सनातनता ,संकलन से वागदेवी काशन्बीकानेर
3. ठठुरतहुआ गणतं) यं य(ह रशंकरपरसा ,तिरछ रेखाएं ,वाणी काशन द ली
4. लछमा रेखाचि (महादेवी वमा ,अतीत के चलचि ,वाणी काशन द ली
5. अ का उड़ान प र छेद
6. ए .पी .जे .अ दुल कलाम भात काशन्नई द ली
7. भेड़ाघाट :माब लॉ सौरधुँआधार - अमृत लाल बेगड़ ,अमृत यनम दा ,थ म य देश्अकादमी ,भोपाल ,म य देश
8. आवाज का नीलाम) एकांक (धम वीरभारती ग - भा- डॉ .नवल कशोर् पंचशील काशन्जयपुर
9. ावचेती वजयदान्देथा ,आठटलुक प का.10.05
10. ह द्भाषा और उसक वरासत: डॉ . व ानिवास्मि , ह द्सा ह य्का पुनरावलोकन , व मिवास मि , भा काशन् द ली
11. सुसंग-कुसंग -सीताराम मह षकृ ष्णकुट रतनगढ़ ,चु) राज.
12. ये ह ोफ़ेसरशशांक - डॉ . व णुकांसा ी- मरण्को पाथेय बनने दो 'सं ह लोक भारती ,इलाहाबाद)) उ .)
13. तुलसी के का यम कुराज और सुराज-' ोसूय साद्द ,सा ह य्क ,54निराला नगर ,लखनऊ) उ .

प संकलन

1. गंगावतरण ,भारत दुह र ' भारत दुसम 'संपादक ,हेमंत शमा ह द काशन्सं थान्वाराणसी)

2. गोवध नधारण ,ह रऔध य वास‘महाका य ह दसा ह यकुट र वाराणसी उ .)
3. भारत वंदना ,मैथिली शरण गु ’ मंगल घट ‘का य श्रा ह)यनीला बर प रधान्सदन ,चिरगाँव ,झाँसी
4. समर शेष है ,रामधार सिंह दनकर,परशुराम क ती ‘ा श्रे ,राजपाल एंड स स् द ली
5. वीर का कैसा हो बसंत ,सुभ द्रकुमार चौहान’ ,सुभ द्रकुमार चौहान ‘संपादक सुधा चौहान सा ह अकादमी ,नई द ली
6. चल पड़े जधरदो डग ,सोहन लाल वेदरा ीयगीत सं हसा ह अकादमी, नई द ली
7. म्दयाकृ ण वजय मधरा ‘अच ना काशन,अजमेर
8. भारती क साधना ,इ ुद्रोखर त पु ’षहमारा कोणमा रका5/70 ‘ मानसरोवर ,जयपुर ,राज.

PHYSICS
PAPER III - MECHANICS

UNIT-I
Inertial frames, Galilean transformation, Non-inertial frames, fictitious forces, Displacement, velocity and acceleration in rotating co-ordinate systems, centrifugal acceleration, Coriolis force and its applications, Foucault pendulum, Invariance of velocity of light, postulates of special theory of relativity, Lorentz transformations, relativistic addition of velocities, length contraction, time dilation, Variation of mass with velocity, mass energy relation. Motion under central force, Kelper's laws, Gravitational law and field. Potential due to a spherical body, Gauss and Poisson equations for gravitational self energy.

UNIT-II
System of particles, centre of mass, motion of centre of mass, concept of reduced mass , single stage and multistage rocket, energy and momentum conservation, concepts of elastic and inelastic collisions, Analysis of collision in centre of mass frame. Angular momentum of a system of particles, Conservation of angular momentum, angular momentum about an arbitrary point, rigid body motion. Rotational motion, equation of motion of a rotating body, inertial coefficients, case of J not parallel to w, kinetic energy of rotation and idea of principles axes, Euler's Equations, Processional motion of Spinning

top, Spin precession in constant magnetic field Calculation of moment of inertia of a spherical shell, hollow and solid spheres and cylindrical objects (cylindrical shell, solid cylinder) about their symmetric axes through centre of mass.

UNIT-III

Kinematics of moving fluids, Equation of continuity, Euler's equation, Berndulli's theorem, Viscous fluids, Stream line and Turbulent flow, Poiseuille's law, Capillary tube flow, Reynold's number, Stokes law, Surface tension and surface energy, molecular interpretation of surface tension, Pressure on a curved liquid surface, wetting. Elasticity, Small deformations, Young's modulus, Bulk modulus and Modulus of rigidity for an isotropic solid, Poisson ratio, relation between elastic constants. Theory of bending of beams and Cantilever, Torsion of a cylinder, Bending moments and Shearing forces. Experimental determinationof elastic constants by bending of beam.

Text and Reference Books :

1. Berkeley Physics Course Vol-I, Mechanics"(Mc Graw-Hill)
2. The Feymman Lectures in Physics, Vol-I, R.P. Feymman, R.B. Lighton and M. Sands.
3. R.S. Gambhir-Mechanics, (CBS Publishers and Distributors, New Delhi.)

PAPER-IV WAVES & OSCILLATIONS

UNIT-I

Potential well and periodic oscillations, cases of harmonic oscillations, differential equations and its solution, Kinetic and potential energy. Simple harmonic oscillations in-Spring and mass system, Simple and compound pendulum, Torsional pendulum, Bifilar oscillations, Helmholtz resonator, LC circuits, oscillation of magnet, Oscillation of two masses connected by a spring. Superposition of two simple harmonic motions of same frequency along the same line, Interference, Damped harmonic oscillators, Power dissipation, Quality factor, Driven harmonic oscillator, Transient and steady state, Power absorption, Motion of two coupled oscillators, normal modes, and motion in mixed mode effect of coupling in mechanical systems. N coupled oscillators.

UNIT-II

Waves in media: Speed of transverse waves on a uniform string, speed of longitudinal waves in a fluid. energy density and energy transmission in Waves, Typical measurement, Waves Over liquid surface, gravity waves and ripples, Group velocity and phase velocity, their measurements, superposition's of waves linear homogeneous equations and the superposition principle, nonlinear superposition and consequences. Standing waves: Standing waves as normal modes of bounded systems, Harmonics, the quality of sound: examples.

Chladni's figures and vibrations of a drum. Production and detection of ultrasonic and infrasonic waves and applications.

UNIT-III

Noise and Music : The human ear and its responses: limits of human audibility. Intensity and loudness, bel and decibel, the musical scale. Temperament and musical instruments. Reflection. Refraction and diffraction of sound: Acoustic impedance of a medium. Percentage reflection and refraction at a boundary. Impedance matching for transducers, diffraction of sound, principle of a sonar system. Sound ranging. Applied acoustics: Transducers and their characteristics. Recording and reproduction of sounds. Various systems, Measurements of frequency. Waveform. Intensity and velocity. The acoustics of halls. Reverberation period. Sabine's formula. Plane electromagnetic waves in vacuum, Wave equation for E and B of linearly, circularly and elliptically polarized electromagnetic waves, Poynting vector; Reflection and refraction at a plane boundary of dielectrics, Polarization by reflection and total internal reflection, Faraday effect, Wave in conducting medium, Reflection and refraction by the ionosphere.

Text and Reference books :

1. D. P. Khandelwal – Oscillation and waves (Himalaya Publishing House, Mumbai).
2. R.K. Ghose – The Mathematics of waves and vibrations.
3. S.N. Ghose – Electromagnetic theory and waves propagation (Narosa Pub. House).
4. V.V. Savate – Electromagnetic field and waves (Wiley Eastern Ltd. N.Delhi).
5. I.G. Main – Vibrations and waves (Cambridge Univ Press).
6. H.J. Pain – The Physics of vibrations and waves (Macmilan 1975).
7. Berkley-Physics course, Vol. III "Waves and Oscillations".

CHEMISTRY

PAPER – V INORGANIC CHEMISTRY

Unit- I

A. Atomic Structure

Idea of de Brogile matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of ø and ø2, 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 configuration of the elements, effective nuclear charge.

B. Chemical Bonding

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 NH3, H3O+, SF4, CIF3, ICl- 2, and H2O, MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicentre bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

Unit- II

A. Periodic Properties

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

B. s-Block Elements Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, and introduction to alkyls and aryls.

C. p-Block Elements

Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides and halides of groups 13- 16, hydrides of boron-diborane and higher boranes, borazine, properties borohydrides.

Unit- III

A. Ionic Solids- Ionic structures, radius ratio 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.

B. Weak Interactions- Hydrogen bonding, van der Waals forces.

C. Fullerenes, carbides, flurocarbons, silicates (Structural principle), tetrasulphur tetranitride, basic properties of halogens, interhalogens and polyhalides.

D. Chemistry of Noble Gases Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.

PAPER –VI ORGANIC CHEMISTRY

UNIT-I

A. Structure and Bonding Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions,

inclusion compounds, clatherates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.
B. Mechanism of Organic Reactions Curved arrow notation, drawing electron movements with arrows, halfheaded and double headed arrows, homolytic and heterolytic bond breaking. Types of reagents-electrophiles and nucleophiles. Types of organic reactions. Energy considerations. Reactive intermediatescarbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with example). Assigning formal charges on intermediates and other ionic species.
C. Stereochemistry of Organic Compounds Concept of isomerism. Types of isomerism. Optical isomerism-elements of symmetry, molecular chirality, enatiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of ennantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism-determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism- conformational analysis of ethane and nbutane; 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-II

A. Alkanes and Cycloalkanes IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation (withspecial 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 strainless rings. The case of cyclopropane ring: banana bonds.
B.Alkenes Nomenclature of alkenes, methods of formation, mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hofmann , physical properties and relative stabilities of alkenes. Chemical reactions of alkenes-mechanisms involved in hydrogenation, electrophilic and free radical additions. Markownikoff 's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration hydroxylation and oxidation with KMnO4.

Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene.
C. Cycloalkenes, Dienes and Alkynes 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 reactions-1,2 and 1,4 additions, Diels-Alder reaction. Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroborationoxidation, metal-ammonia reductions, oxidation and polymerization.

UNIT-III
A. 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 Huckle rule, aromatic ions.
B. Aromatic electrophilic substitution- general pattern of the mechanism, role of _ and _ Complexes. Mechanism of nitration, halogenation, ulphonation, 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.
C. Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.
D. Alkyl and Aryl Halides Nomenclature and classes of alkyl halides, Methods of formation, chemical reaction. Mechanisms of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 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.

MATHEMATICS
PAPER VII ALGEBRA AND MATRICES

UNIT - I
(Matrices)
Hermitian and skew Hermitian matrices. Elementary Operations on matrices. Inverse of a matrix. Linear independence of row and column matrices. Row rank, column rank and rank of a matrix. Equivalence of column and row ranks.

Eigen values, Eigen vectors and the characteristic equation of a matrix. Cayley-Hamilton theorem and its use in finding inverse of a matrix. Applications of matrices to solve a system of linear (both homogeneous and non homogeneous) equations. Theorems on consistency of a system of linear equations. Relation between the roots and coefficients of general polynomial equation in one variable, Transformation of equations. Descarte's rule of signs. Solution of Cubic equations (Cardon method), Bi-quadratic equations.

UNIT - II

(Group Theory)

Definition of a group with examples. Order of a finite group. General properties of groups. Integral powers of an element of a group. Order of an element of a group. Subgroups. Generation of groups. Cyclic groups, Coset Decomposition, Lagrange's theorem and its consequences, Fermats and Euler's theorems.

UNIT - III

Normal subgroups and Quotient groups. Permutation, Permutation groups, Cyclic permutations, Even and odd permutations. The alternating group An , Cayley's theorem. Morphism of Groups, Homomorphism and Isomorphism, The fundamental theorem of homomorphism.

PAPER VIII CALCULUS

UNIT - I

(Differential Calculus)

Derivative of the length of an arc, Curvature, various formulae, Centre of curvature, Chord of curvature and related problems, Asymptotes. Concavity and convexity. Singular point, Double point. Curve tracing (in cartesian and polar co-ordinates.)

UNIT - II

(Integral Calculus)

Quadrature, Rectification, Intrinsic equation, Volume and Surfaces of solids of revolution.

UNIT - III

(Ordinary Differential Equations)

Concept and formation of a Differential Eauation, Order and Degree of a Differential equation, Equations of first order and first degree, Equation in which the variables are separable, Linear differential equations, Bernoulle's equation, Homogeneous equations, Linear equations and Equations reducible to the linear form. Exact differential equations, Differential equations of first order

and higher degree; solvable for x, y, p, Clairaut's form, Singular solutions. Geometrical meaning of a differential equation, Orthogonal trajectories, Linear differential equations with constant coefficients, Ordinary homogeneous linear differential equations.

YEAR 2

PHYSICS

PAPER – I – THERMODYNAMICS AND STATISTICAL PHYSICS

Unit – I

Kinetic Theory of Gases The Distribution of molecular velocities : distribution law of molecular velocities, Most probable, Average and R.M.S. velocities, Energy distribution function, Effusion and molecular beam, Experimental verification of the Maxwell velocity distribution, the principle of equipartition of energy. Transport Phenomenon : Mean free path, distribution of free paths, Coefficients of viscosity, thermal conductivity, diffusion and their interrelation.
Thermodynamic Interactions : Thermal interaction, Zeroth law of thermodynamics, System in thermal contact with a heat reservoir (canonical distribution), Energy fluctuations, Entropy of a system in a heat bath. Helmholtz free energy, adiabatic interaction and Enthalpy, General interaction and first law of thermodynamics, Infinitesimal general interaction, Gibbs free energy, Phase transitions.

UNIT II

Clausius-Clapeyron equation, vapor pressure curve. Heat engine and efficiency of engine, Carnot cycle, Thermodynamics scale as an absolute scale, Maxwell relations and their applications. Production of low temperatures and applications: Joule Thomson expansion and J.T. coefficients for ideal as well as van der Waals gas, Porous plug experiment, Temperature inversion, Regenerative cooling, Cooling by adiabatic demagnetization, Liquid Helium, He-I and He-II, Super fluidity, Refrigeration through helium dilution, Quest for absolute Zero, Nernst heat theorem. Classical Statistics : Validity of classical approximation, Phase space, Micro and Macro states, thermodynamic probability, relation between entropy and thermodynamic probability, Monatomic Ideal gas, Barometric equation

Unit – III

Specific heat capacity of diatomic gas, Specific heat capacity of solids. Quantum Statistics : Black body radiation and failure of classical statistics,

Postulates of quantum statistics, Indistinguishibility, Wave function and exchange degeneracy, a priory probability, Bose Einstein statistics and its distribution function, Planck distribution function and radiation formula, Fermi Diarc statistics and its distribution function, Contact Potential, Thermionic emission, Specific heat anomaly of metals, Nuclear spin statistics
(ortho and para hydrogen).

Reference Books :

1. Berkeley Physics Course Vol. V-Statistical Physics.
2. Reif-Thermodynamics and Statistical Physics
3. Loknathan and Khandelwal-Thermodynamics and Statistical Physics.
4. Sears-Thermodynamics Kinetic Theroy of gases and Statistical Physics.
5. Kittle – Thermal Physics.

PAPER – II – ELECTRONICS

Unit – I

Circuit analysis : Networks some important definitions, loop and nodal equations based on DC and AC circuits (Kirchhoff's Laws). Four terminal networks : current voltage conventions, open, close and hybrid parameters of any four terminal network, Input, output and mutual independence for an active four terminal network. Various circuits theorems : Superposition, Thevenin, Norton, reciprocity, maximum power transfer and Miller Theorems.Semi-conductors : Charge densities in N and P materials, conduction by drift and diffusion of charge carriers. PN diode equation, capacitance effects, nature of charge carriers by Hall effect.

Unit – II

Rectifiers: Half wave, full wave and Bridge rectifier, calculation of ripple factor, efficiency and regulation. Filters, series inductor, shunt capacitor, L section and _ section filters. Voltage regulation : Voltage regulation and voltage stabilization by Zener diode, voltage multiplier. Transistor and transistor bias circuits: Notations and volt-ampere characteristics for bipolar junctions transistor. Concept of load line and operating point, Hybrid parameters. Use of transistor as amplifier : CB, CE, CC configurations and their equivalent circuit, Analysis of transistor amplifiers using hybrid parameters and its gain frequency response. Cascade amplifiers, basic idea of direct coupled and R-Coupled amplifiers, Differential amplifiers. Need of bias and stability of Q Point : stability factors, various types of bias circuits for thermal bias stability. Fixed bias, collector to base feed back bias and four resistor bias. Amplifier with Feed back : Concept of feed back, positive and negative feed back. Voltage and current feed back circuits. Advantages of negative feed back : Stabilization of

gain. Effect of negative feed back on output and input resistance, Reduction of nonlinear distortion, effect on gain-frequency response.

UNIT-III

Oscillators : Criteria for self excited and self sustained oscillators circuit requirement for build-up of oscillation. Basic transistor oscillator circuit and its analysis; Colpitts and Hartley oscillators. R-C Oscillators, crystal oscillators and its advantages. Field effect transistors and logic circuits : Junction Field effect transistor (JFET), circuit symbols, biasing and volt-Ampere relations. Logic Circuits : Transistor as a switch, logic fundamentals, AND, OR, NOT, NOR, NAND, XOR gates. Boolean algebra, De Morgan's theorem, positive and negative logic, logic gates circuits realization using DTL and TTL logic, Simplification of Boolean expressions.

Reference:

1. John D. Ryder, Electronic Fundamentals and Applications. Prentice Hall of India Pvt. Ltd. New Delhi.
2. John D. Ryder, Engineering Electronics : Mc Graw Hill Book
3. Jacob Millman anc Christose Hailkias, Integrated Electronics Analog and Digital Circuits and systems, Mc Graw Hill Ltd.
4. Albert Paul Malvino, digital computer electronics, Tata Mc Graw Hill Co. Ltd. New Delhi

CHEMISTRY

PAPER III INORGANIC CHEMISTRY

Unit I

A. 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.

B. Chemistry of Lanthanide Elements Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds.

Unit II

Chemistry of Actinides General features and chemistry of actinides, chemistry of separation ofNp, Pu and Am from U, similarities between the later actinides and the later lanthanides. Oxidation and Reduction Use of redox potential data-

analysis of redox cycle, redox stability in water-Frost, Latimer and Pourbaix diagrams. Principles involved in the extraction of the elements.

Unit III

Acids and Bases Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concepts of acids and bases. Non-aqueous Solvents Physical properties of a solvent, types of solvents and their general characteristics reactions in non-aqueous solvents with reference to liquid NH3 and liquid SO2.

PAPER IV ORGANIC CHEMISTRY

Unit I

A. 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. Bathchoromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones. Infrared (IR) absorption spectroscopymolecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorption of various functional groups and interpretation of IR spectra of simple organic compounds.
B. 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.

Unit II

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 HIO4] and pinacolpinacolone rearrangement. Trihydric alcohols- nomenclature and methods of formation, chemical reactions of glycerol. Phenols Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols-electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben- Hooesch reaction, Lederer-Manasse reaction and Reimeer-Tiemann reaction. 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. 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 substituion. Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms of esterfication and hydrolysis (acidic and basic).

Unit III

A. Aldehydes and Ketones Nomenclature and structure of carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acid. Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Witting reaction. Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-villiger oxidation of ketones, Cannizzaro reaction. MPV, Clemmensen, Wolff-kishner, LiAIH4 and NaBH4 reductions, Halogenation of enolizable ketones. An introduction to á,â unsaturated aldehydes and ketones. B. 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 teritary amines. Structural features effecting basicity of amines. Amines salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles),reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reaction of amines, electrophilic aromatic substitution in aryl amines, reaction of amines with nitrous acid. Synthetic transformation of aryl diazonium salts, azo coupling.

MATHEMATICS
PAPER V - ADVANCED CALCULUS

UNIT - I

Advanced Differential Calculus

definition of the limit of a function, Basic properties of limits, Continous functions and classification of discontinuities, Sequential Continuity, properties of continuous functions defined on closed intervals, Limit and Continuity of functions of two variables, Partial Differentiation, Change of variables, Euler's theorem on homogeneous functions, Jacobians. Differentiability, Chain rule of differentiability. Mean Value Theorems and their geometrical interpretation, Darboux's intermediate value theorem for derivatives, Taylor's theorem for functions of two variables, Envelopes, Evolutes, Maxima, minima and saddle points of functions of two variables, Lagrange's multiplier method.

UNIT - II

Advanced Integral Calculus

Beta and Gamma functions, Double and Triple integrals, Dirichlet's integrals, Change of order of integration in double integrals. Riemann integral, Integrability of continuous and monotonic functions. Darboux theorem, Fundamental theorem of integral calculus, Mean value theorems of integral calculus.

UNIT - III

Definition of a sequence, Theorems on limits of sequences, Bounded and monotonic sequences, Cauchy's convergence criterion, Infinite series of non-negative terms, its convergence, Different tests of convergence of infinite series i.e. comparison tests, Cauchy's integral tests, Ratio tests, Raabe's Logarithmic, Morgan and Bertrand's tests (without proof), Alternating series, test Leibnitz's theorem, Absolute and conditional convergence. Fourier series, Fourier expansion of piecewise monotonic functions, Uniform convergence of series of functions, Wirestrass M-test, Abel’s test and Dirichlet’s test.

PAPER VI - DIFFERENTIAL EQUATIONS

UNIT - I

Ordinary Differential Equations

Linear differential equations of second order, Normal Form, Transformation of the equations by changing the dependent / independent variable. Method of variation of parameters, Ordinary Simultaneous differential equations. Total differential equations, Exact differential equations of nth order.

UNIT - II

Series solution of differential equations, Power series method, Bessel, Legendre and Hypergeometric equations, Bessel, Legendre and Hypergeometric functions and their properties.

UNIT III

Laplace transformation, Properties and Laplace transformation of some standard functions. Laplace transform of the derivative, Inverse Laplace transformation and its applications in solving differential equations.

YEAR III

PHYSICS

PAPER-I QUANTUM MECHANICS AND SPECTROSCOPY

Unit I

Origin of Quantum theory : Failure of classical Physics to explain the phenomenon such as black body spectrum, Planck's radiation law, photoelectric effect and Einstein explanation, Compton effect deBroglie hypothesis, evidence for diffraction and interference of particles. Uncertainty principle and its consequences gamma ray microscope, diffraction at a single slit, Application of uncertainty principle, (i) Non existence of electron in nucleus. (ii) Ground state energy of H-atom (iii) Ground state energy of harmonic oscillator, Energy-time uncertainty. Schrodinger equation – time dependent and time independent form, Physical significance of the wave function and its interpretation, probability current density, operators in quantum mechanics, linear and Hermitian operators, Expectation values of dynamical variables, the position, momentum, energy.

Unit II

Fundamental postulates of quantum mechanics, eigen function and eigen value, degeneracy , orthogonality of eigen functions, commutation relations . Ehrenfest theorem, concept of group and phase velocities, wave packet. Simple Solutions of Schrodinger equation : Time independent Schrodinger equation and stationary state solution, Boundary and continuity conditions on the wave function, particle in one dimensional box , eigen function and eigen values , discrete energy levels, extension of results for three dimensional case and degeneracy of levels. Potential step and rectangular potential barrier , calculation of reflection and transmission coefficient, Qualitative discussion of

the application to alpha decay(tunnel effect), square well potential problem, calculation of transmission coefficient. Bound State Problems :Particle in one dimensional infinite potential well and finite depth potential well, energy value and eigen functions.

Unit III

Simple harmonic oscillator (one dimensional) eigen function, energy eigen values, zero point energy. Schrodinger equation for a spherically symmetric potential, Separation of variables, Orbital angular momentum and its quantisation, spherical harmonics, energy levels of H-atom, shape of n=1, n=2 wave functions, comparison with Bohr model and Correspondence principle.
Elementary Spectroscopy : Quantum features of one electron atoms, Frank-Hertz experiment and discrete energy states, Stern and Gerlach experiment, Spin and Magnetic moment, Spin Orbit coupling and qualitative explanation of fine structure. Atoms in a magnetic field, Zeeman effect, Zeeman splitting. Qualitative features of molecular spectroscopy, Rigid rotator, discussion of energy eigenvalues and eigenfunctions, Rotational energy levels of diatomic molecules, Rotational spectra, Vibrational energy levels of diatomic molecules, Vibrational spectra, Vibrational Rotational spectra, Raman effect.

Text and Reference Books

1. H. S. Mani and G.K.Mehta, Introduction to modern Physics, (Affl. East West Press1989)
2. A. Beiser, Prospective of modern Physics
3. H.E. White, Introduction to Atomic Physics.
4. Barrow, Introduction to Molecular Physics.
5. D.P.Khandelwal, Optics and Atomic Physics (Himalaya Pub. House Mumbai 1988)

PAPER – II NUCLEAR PHYSICS

Unit-I

Nuclear Properties : Rutherford's Theory of a Particle Scattering, Properties of Nuclei : Quadrupole Moment and Nuclear Ellipticity, Quadrupole Moment and Nuclear Spin, Parity and Orbital Angulr Momentum, Parity and Its Conservation, Nuclear Mass and Mass Spectroscopy, Nuclear Energy, Explanation of the fact that Electrons Cannot Exist with-in a Nucleus, Discovery of Neutron and Proton-Neutron Hypothesis, Neutron to Proton Ratio (N/Z), The Nuclear Potential, Nuclear Mass, Atomic Mass Unit (a.m.u.), Mass Defect and Binding Energy, Nuclear Forces, Theory of Nuclear Forces, The

Liquid Drop Model. Cosmic Rays : Discovery of Cosmic Rays, Nature of Cosmic Rays, soft and hard, components, variation in cosmic rays—
(1) Latitude Effect
(2) East-West Asymmetry or Directional Effect
(3) Altitude Effect
Detection of Cosmic Ray Particles, Origin of Cosmic Rays.

Unit-II

Nuclear Fission : The Discovery of Nuclear Fission, The Energy Release In Fission, The Fission products, Mass Distribution of Fission Products, Fission Cross Section and Threshold, Neutron Emission In Fission, The Prompt Neutron and Delayed Neutrons, Energy of Fission Neutrons, Theory of Nuclear Fission and Liquid Drop Model, Barrier Penteration- Theory of Spontaneous Fission, Nuclear Energy Sources, Nuclear Fission as a Source of Energy, The Nuclear Chain Reaction, Condition of Controlled Chain Reaction, The Principle of Nuclear Reactors, Classification of Reactors, Typical Reactors, Power of Nuclear Reactors, Critical size of Thermal Reactors, The Breeder Reactors, Reprocessing of the Spent Fuel, Radiation Damages and Fission Products Poisoning, Uses of Atomic Energy. Nuclear Fusion : The Sources of Stellar Energy, The Plasma : The Fourth State of The Matter, Fusion Reaction, Energy Balance and Lawson Criterion, Magnetic Confinement of Plasma, Classical Plasma Losses from the Magnetic Container, Anomalous Losses, Turbulence and Plasma Instabilities, The Laser Fusion Problem, Fusion Reactor.

Unit-III

Elementary Particles : Classification of Elementary Particles, Fundamental Interactions, Unified Approch (Basic ideas), The Conservation Laws, Quarks (Basic ideas), Charmed and Colour Quarks. Accelerators : Ion Sources. CockCroft-Walten High Voltage Generators, VanDeGraff Generators, Drift Tube, Linear Accelerators, Wave Guide Accelerator, Magnetic Focusing in Cyclotron, Synchrocyclotron, Betatron : The Electromagnetic Induction Accelerator, Electron Synchrotron, Proton Synchrotron. Particle and Radiation Detectors : Ionisation Chamber, Region of Multiplicative Operation, Proportion Counter, Geiger-Muller Counter, Scintillation counter, Cloud Chamber.

Text and Reference Books

1. H. S. Mani and G.K.Mehta, Introduction to modern Physics, (Affl. East West Press1989)
2. A. Beiser, Prospective of modern Physics
3. H.A.Enge, Introduction to Nuclear Physics.

PAPER- III INORGANIC CHEMISTRY

Unit-I

A. Metal-ligand Bonding in Transition Metal Complexes Limitations of valence bond theory, an elementary idea of crystal-field theory, crystal field splitting in octahedral , tetrahedral and square planar complexes, factors affecting the crystal-field parameters. B. Thermodynamic and Kinetic Aspect of Metal Complexes A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar and octahedral complexes. C. Magnetic Properties of Transition Metal Complexes Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula. L-S coupling, correlation of ìs and ìeff values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.

Unit-II

A. Electronic Spectra of Transition Metal Complexes Types of electronic transition, selection rules of d-d transitions, spectroscopic ground state, spectrochemical series. Orgel-energy level diagram for d1and d9 states, discussion of the electronic spectrum of [Ti(H2O)6]3+ complex ion. B. Organometallic Chemistry Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti, a brief account of metal-ethylenic complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls.

Unit-III

A. Basics of Bioinorganic Chemistry Essential and trace elements in biological processes, metallporphyrins with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca2+. Nitrogen fixation. B. 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. C. Silicones and Phosphazenes Silicones and phosphazenes as examples of organic polymers, nature of bonding in triphosphazenes.

PAPER-IV ORGANIC CHEMISTRY

UNIT-I

Spectroscopy

A. Nuclear Magnetic resonance (NMR) spectroscopy. Proton magnetic resonance(1H NMR) spectroscopy, nuclear shielding and dishielding chemical

shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2,- tribromoethane, ethyl acetate, toluene and acetophenone. Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.
B. Organometallic Compounds Organomagnesium compounds: the Grignard reagents-formation, structure and chemical reaction. Organozinc compounds:formation and chemical reactions. Organolithium compounds: formation and chemical reactions.

UNIT-II

A. Organic Synthesis via Enolates Acidity of á-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. Carbohydrates Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erithro 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. Structure of ribose and deoxyribose.
An introduction to disaccharides(maltose, sucrose and lactose) and
Polysaccharides (starch and cellulose) without involving structure determination.
C. Amino Acids, Peptides, Proteins and Nucleic Acids Classification, structure and stereochemistry of amino acids. Acid base behavior, isoelectric point and electrophoresis. Preparation and reactions of áamino 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, level of protein structure. Proteins denaturation/ renaturation.
Nucleic acids: introduction, Constitution of nucleic acids. Ribnonucleosides and ribonucleotides. The double helical structure of DNA.

UNIT-III

A. 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 rubbers.

B. Synthetic Dyes Colour and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of Methyl orange, Congo red, malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and indigo.
C. Fats, Oil 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.

MATHEMATICS

PAPER V- ABSTRACT ALGEBRA

Unit - I

Ring theory

Ring, Examples of Rings, Ring with unity, Zero divisors, Integral Domain and Fields, their examples and properties. Characteristic of a ring and intergral domain. Subrings, subfields, Prime filed, Ring homomorphism, Embedding of Rings, Field of quotients of an integral domain. Ideals and their properties. Principal ideal and principal ideal ring, Prime ideal, Maximal ideal. Ideals and Quotient rings, Euclidean rings, Unique Factorisation Domain, Polynomial rings, Remainder theorem, Factor theorem, Polynomials over the rational fields.

Unit - II

Linear Algebra

Vector Spaces : Definition and examples of a vector spaces, subspaces, Sum and direct sum of subspaces, linear span, linear Dependence, Independence and their basic properties, Basis, finite dimensional vector spaces, Existence theorem for basis, invariance of the number of elements of a basis set, Dimension, existence of complimentary subspace of a subspace of a finite dimensional vector space, dimension of sums of subspaces, quotient space and its dimension. Linear transformations : Linear Transformations and their representation as matrices,thealgebra of linear transformations, Sylvesten Law of Nullity.

Unit - III

Change of basis, Dual space,Dual Basis, Bidual space, Adjoint of a linear transformation, Annihilator of a sub space. Eigenvalues and Eigenvectors, Similar matrices, equivalent matrices, Similarity of Linear transformations, Reduction to triangular form, Minimal Polynomial. Diagonalisation of Matrices.

PAPER VI - ANALYSIS

Unit - I

Metric Spaces

Real Number System as a complete Ordered Field. The point set theory, Open and Closed sets, Limit point of a set, Neighbourhood, Bolzano-Weierstrass theorem, Heine-Borel theorem, Compactness, connectedness, Cantor's ternary set. Definition and example of a metric space, Diameter of a set, Bounded set, Open sphere, Interior point and Interior of a set, Derived and Closure of set, Closed set, Closed Sphere, Properties of Open and Closed sets, Boundary point of set.

Unit - II

Convergent and Cauchy sequences, Complete metric space, Cantor's Intersection theorem. Dense subset, Baire Catagory theorem. Limit of a function, Continuous function, Theorem on necessary and sufficient conditions for continuity of a function, Uniform continuity, Contracting mapping, Banach Fixed Point theorem, Equivalant matrices, Compactness, Sequentially compactness, Totally Bounded space, Finite Intersection properties.

Unit - III

Complex Analysis

Complex Numbers as ordered pairs, Complex plane, Geometrical representation, Connected and compact sets, Curves and region in the complex plane, Statement of Jordan curves theorem, Extended complex plane and stereographic projection, Complex valued functions limits.

Paper VII Industry Based Environmental Studies

UNIT – 1

Environment – Definition – Scope – Structure and function of eco system's procedures, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chain, food web and ecological pyramids - concepts of sustainable development.

UNIT – 2

Natural resources: Renewable – air, water, soil, land and wildlife resources. Non- renewable – mineral, coal, oil and gas. Environmental problems related to the extraction and use of natural resources.

UNIT – 3

Biodiversity – Definition – values – consumption use, productive social, ethical, aesthetic and option values threats to biodiversity – Hotspots of bio diversity – conservation of bio-diversity: In-situ Ex-situ. Bio-wealth – national and global level.

UNIT – 4

Environmental pollution : Definition – causes, effects and mitigation measures – Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution – Nuclear hazards – solid wastes acid rain – climate change and global warming environmental laws and regulations in India – Earth summit.

UNIT – 5

Population and environment – Population explosion – Environment and human health – HIV / AIDS – Women and child welfare – Resettlement and Rehabilitation of people, role of information technology in environmental health – Environmental awareness.