Chemistry

Physical Chemistry

1. Basic principles of chemistry:- Importance of chemistry, Nature of Matter, Properties of Matter and their measurement, Uncertainty in measurements, Laws of chemical combinations, Dalton's Atomic Theory, Atomic and Molecular Masses,Mole concept and molar masses Percentage Composition, Stoichiometry and Stoichiometric Calculations

2. Atomic structure:- Sub atomic Particles, Atomic models, Developments Leading to the Bohr's model of atom, Bohr's Model for hydrogen atom, towards Quantum Mechanical model of the Atom, Quantum mechanical model of Atom, Nature of electromagnetic radiation, photoelectric effect limitations of Bohr's model, Dual nature of matter, de-Broglie's relationship, Heisnberg uncertaintiy principle, various quantum numbers (principal, angular momentum and magnetic quantum numbers) and their significance, shapes of s,p and d – orbitals, electron spin quantum number, Rules for filling electrons in orbitals-aufbau principle , Paulli's exclusion principle and Hund's rule, electronic configuration of elements, extra stability of half- filled and completely filled orbitals.

3. States of Matter:-Intermolecular Forces,Thermal Energy, Intermolecular forces vs thermal interactions, The Gaseous state, The Gas laws, Ideal gas equation, Kinetic Molecular theory of Gases, Liquification of Gases, Liquid state

4. Chemical Bonding and Molecular Structure:-Kossel – Lewis approach to chemical bond formation, concept of ionic and covalent bonds, Ionic Bonding, Formation of Ionic bonds, factors affecting the formation of ionic bonds, calculation of lattice enthalpy, Covalent Bonding, Concept of electronegetavitiy, Fajan's rule, dipole moment, Valence Shell Electron Pair Repulsion(VSEPR) theory and shapes of simple molecules, Quantum mechanical approach to covalent bonding , Valence bond theory – its important features, concept of hybridization involving s,p and d orbitals, Resonance, Molecular Orbital Theory ,LCAOs , types of molecular orbitals (bonding, antibonding), sigma and pi-bonds, molecular orbitals electronic configurations of homonuclear diatomic molecules, concept of bond order, bond length and bond energy , Elementary idea of metallic bonding , Hydrogen bonding and its applications.

5. Basic principles and applications of spectroscopy:- Rotational, vibrational, electronic, Raman, ESR, NMR

6. Thermodynamics:- Fundamental of thermodynamics , System and surroundings, extensive and intensive properties, state functions, types of processes, First law of thermodynamics ,concept of work, heat internal energy and enthalpy , heat capacity, molar heat capacity, Hess's law of constant heat summation , Enthalpies of bond dissociation, combustion ,formation, atomization,sublimation , phase transition, hydration, Ionisationand solution. Second law of thermodynamics, Spontaneity of processes, ΔS of the universe and ΔG of the s system as criteria for spontaneity, ΔG° (standard Gibbs energy change) and equilibrium constant.

7. Equilibrium:- Meaning of equilibrium, concept of dynamic equilibrium. Equilibria involving physical processes: Solid - liquid, liquid - gas and solid - gas equilibria, Henry's

law, general characterics of equilibrium involving physical processes. Equilibria involving chemical process: Law of chemical equilibrium, equilibrium constants (Kp and Kc) and their significance, significance of ΔG and ΔG° in chemical equilibria, factors affecting equilibrium concentration, pressure, temperature, effect of catalyst; Le Chatelier's principle. Ionic equilibrium: Weak and strong electrolytes, ionization of electrolytes, various concepts of acids and bases (Arthenius Bronsted - Lowry and Lewis) and their ionization, acid - base equilibria (including multistage ionization) and ionization constants, ionization of water, pH scale, common ion effect, hydrolysis of salts and pH of their solutions, solubility of sparingly soluble salts and solubility products, buffer solutions.

8. Redox Reactions and Electrochemistry:- Electronic concept of oxidation and reduction, redox reactions, oxidation number, rules for assigning oxidation number balancing of redox reactions. Eectrolytic and metallic conduction, conductance in electrolytic solutions, specific and molar conductivities and their variation with concentration: Kohlrausch's law and its applications. Electrochemical cells - Electrolytic and Galvanic cells, different types of electrodes, electrode potentials including standard electrode potential, half-cell and cell reactions, emf of a Galvanic cell and its measurement; Nernst equation and its applications; Relationship between cell potential and Gibbs' energy change, Dry cell and lead accumulator; Fuel cells.

9. Chemical Kinetics:- Rate of a chemical reactions, factors affecting the rate of reactions: concentration, temperature, pressure and catalyst; elementary and complex reactions, order and molecularity of reactions, rate law, constant and its units, differential and integral forms of zero and first order reactions, their characteristics and half-lives, effect of temperature on rate of reactions - Arrhenius theory, activation energy and its calculation, collision theory of bimolecular gaseous reactions (no derivation).

10. Surface chemistry:- Adsorption - Physisorption and chemisorptions and their characteristics, factors affecting adsorption of gases on solids - Freundlich and Langmuir adsorption isotherms, adsorption from solutions, Colliodal state - distinction among true solutions, colloids and suspensions, classification of colloids - lyophilic, lyophobic; multi molecular, macromolecular and associated colloids (micelles), preparation and properties of colloids - Tyndal effect, Brownian movement, electrophoresis, dialysis, coagulation and flocculation; Emulsions and their characteristics.

11. Solid States-: General Characteristics of solid state, Amorphous and Crystalline Solids, Classification of Crystalline Solids, Crystal Lattices and Unit Cell, Close-Packed Structures, Packing Efficiency, Calculations Involving Unit Cell Dimensions, Imperfections in Solids, Electrical Properties, Magnetic Properties.

12. Concepts of catalysis:- Homogenous and heterogeneous catalysis,

13. Solutions:- Types of Solutions, Expressing concentration of solutions, Solubility, Vapour pressure of liquid solutions, Ideal and Non-ideal solutions, Colligative Properties and Determination of Molar Mass, Abnormal Molar Masses

Inorganic Chemistry

1. Chemical periodicity:- Modern periodic law and present form of the periodic tables, s, p,

d and f block elements, periodic trends in properties of elements atomic and ionic radii, ionization enthalpy, electron gain enthalpy, valence, oxidation states and chemical reactivity.

2. General principles & process of isolation of metals:- Modes of occurrence of elements in nature, minerals, ores; Steps involved in the extraction of metals - concentration, reduction (chemical and electrolytic methods) and refining with special reference to the extraction of Al, Cu, Zn and Fe; Thermodynamic and electrochemical principles involved in the extraction of metals.

3. Hydrogen:- Position of hydrogen in periodic table, isotopes, preparation, properties and uses of hydrogen; Physical and chemical properties of water and heavy water, Structure preparation, reactions and uses of hydrogen peroxide; Hydrogen as a fuel.

4. S-Block elements:- Group-1 and 2 elements introduction, electronic configuration and general trends in physical and chemical properties of elements, anomalous properties of the first element of each group, diagonal relationships. Preparation and properties of some important compounds - sodium carbonate and sodium hydroxide; Industrial uses of lime, limestone Plaster of Paris and cement; Biological significance of Na, K, Mg and Ca.

5. P-Block elements:- Group 13 to Group 18 elements, Electronic configuration general trends in physical and chemical properties of elements across the periods and down the group; unique behavior of the first element in each group. Preparation, properties and uses of boron and aluminium; properties of boric acid, diboron, boron trifluride, aluminium chloride and alums, Allotropes of carbon, catenation; Structure & properties of silicates and zeolites. Properties and uses of nitrogen and phosphorus; Allotrophic forms, structure and uses of ammonia, nitric acid, and PCl3, PCl5; Structures of oxides of phosphorus. Preparation, properties, structures and uses of ozone; Allotropic forms of sulphur, sulphuric acid and structures of oxoacids of sulphur.

6. d-&f Block elements:- Position in periodic table, electronic configurations of d-block elements, general properties of the transition elements (d-Block), some important compounds of transition elements, the lanthanoids, the actinoids, some application of d^3 and f-Block elements. Preparation, properties and uses of $K_2Cr_2O_7$ and $KMnO_4$.

7. Co-ordination compounds & Organometallic compounds:- Introduction to co-ordination compounds, Werner's theory; ligands, co-ordination number, denticity, chelation; IUPAC nomenclature of mononuclear co-ordination compounds, isomerism; Bonding - Valence bond approach and basic ideas of Crystal field theory, colour and magnetic properties; Importance of co-ordination compounds (in qualitative analysis, extraction of metals and in biological systems), Organmetallic comounds-synthesis, bonding and structure, and reactivity. Organometallics in homogenous catalysis. Cages and metal clusters.

8. Environmental Chemistry:- Environmental pollution - Atmospheric, water and soil, Atmospheric pollution-Tropospheric and Stratospheric Tropospheric pollutants- Gaseous pollutants: Oxides of carbon, nitrogen and sulphur, hydrocarbons; their sources, harmful effects and prevention; Green house effect and Global warming; Acid rain; Particulate pollutants: Smoke, dust, smog, fumes, mist; their sources, harmful effects and

prevention. Stratospheric pollution - Formation and breakdown of ozone, depletion of ozone layer-its mechanism and effects. Water Pollution-Major pollutants such as, pathogens, organic wastes and chemical pollutants; their harmful effects and prevention. Soil pollution - Major pollutants such as: Pesticides (insecticides, herbicides and fungicidies), their harmful effects and prevention. Strategies to control environmental pollution.

9. **Nuclear Chemistry:-** Nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

10. **Analytical chemistry:-** Separation techniques, Spectroscopic electro and thermoanalytical methods.

11. **Bioinorganic Chemistry:-** Photosystems, porphyrines, metalloenzymes, oxygen transport, electron transfer reactions, nitrogen fixation.

12. **Physical characterization of inorganic compounds by IR, Raman, NMR, EPR, Mossbauer,** UV-, NQR, MS, electron spectroscopy and microscopic techniques.

Organic Chemistry

1. **Purification & Characterisation of organic compounds:-** Purification – Crystallization, sublimation, distillation, differential extraction and chromatography – principles and their applications. Qualitative analysis – Detection of nitrogen, sulphur, phosphorus and halogens. Quantitaive analysis– Estimation of carbon, hydrogen, nitrogen, halogens, sulphur, phosphorus. Calculations of empirical formulae and molecular formulae; Numerical problems in organic quantitative analysis.

2. **Some basic principles of organic chemistry:-** Tetravalency of carbon – Shapes of simple molecules – hybridization (s and p); Classification of organic compounds based on functional groups :- C = C -, -Carbon Carbon triple bond and those containing halogens, oxygen, nitrogen and sulphur, Homologus series; Isomerism –structuraland stereoisomerism. Nomenclature (Trivial and IUPAC) Covalent bond – Homolytic and heterolytic : free radicals, carbocations and carbanions; stability of carbocations and free radicals, eleectrophiles and nucleophiles. Electronic displacement in a covalent bond – Inductive effect, electromeric effect, resonance and hyperconjugation.

3. **Chemistry of Hydrocarbon:-** Classification, Isomersim IUPAC nomenclature, general methods of preparation, properties and reactions. Alkanes – Conformations : Sawhorse and Newman projections (of ethane); Mechanism of halogenations of alkanes. Alkenes – Geometrical isomerism; Mechanism of electrophilic addition: additioe of hydrogen halogens, water hydrogen halides (Markownikoff's and peroxide effect); Ozonolysis and polymerization. Alkynes – Acidic character, Addition of hydrogen, halogens, water and hydrogen halides; Polymerization. Aromatic hydrocarbons – Nomenclature, benzene – structure and aromaticity: Mechanism of electrophillic substitution: halogenations, nitration, Friedel – Craft's alkylation and acylation, directive influence of functional group in mono – substituted benzene.

4. **Organic compounds – containing Halogens:-** General methods of preparation, properties and reactions; Nature of C –X bond; Mechanisms of substitution reactions; Uses; Environmental effects of chloroform & iodoform.

5. **Organic compounds – containing Oxygen:-** General methods of preparation, properties, reactions and uses. Alcohols, Phenols and Ethers Alcohols: Identification of primary, secondary and tertiary alcoholos; mechanism of dehydration. Phenols: Acidic nature, electrophillic substitution reactions : halogenations, nitration and sulphonation, Reimer – Tiemann reaction. Ethers : Structure. Aldehyde and ketones : Nature of carbonyl group; Nucleophilic addition to >C=O group, relative reactivities of aldehydes and ketones: Important reactions such as – Nucleophilic addition reactions (addition of HCN, NH3 and its derivatives), Grignard reagent; oxidation; reduction (Wolff Kishner and Clemmensen); acidity of hydrogen, aldol condensation, Cannizzaro reaction, Haloform reaction; Chemical tests to distinguish between aldehydes and Ketones. Methods of preparation properties, reactions and uses of carboxylic acids, acidic strength and factors affecting it.

6. **Organic compounds – containing Nitrogen:-** General methods of preparation, properties, reactions and uses. Amines: Nomenclature, classification, structure, basic character and identification of primary, secondary and tertiary amines and their basic character. Diazonium salts: Importance in synthetic organic chemistry.

7. **Polymers:-** General introduction and classification of polymers, general methods of polymerization – addition and condensation, copolymerization; Natural and synthetic rubber and vulcanization; some important polymers with emphasis on their monomers and uses – polythene, nylon, polyester and bakalite.

8. **Biomolecules:-**General introduction and importance of biomolecules. Carbohydrates-Classification : aldoses and ketoses; monosaccharides and constituent monosaccharides of oligosaccharides, starch. Proteins – primary, secondary, tertiary and quaternary structure (qualitative ides only), denaturation of proteins, enzymes. Vitamins – Classification and functions. Nucleic Acids – Chemical constitution of DNA and RNA. Biological functions of nucleic acids.

9. **Chemistry in Everyday Life:-** Chemical in medicines – Analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamins – their meaning and common examples. Chemical in food – Preservatives, artificial sweetening agents – common examples. Cleansing agents – Soaps and detergents, cleansing action.

10. Common reagents (organic, inorganic and organometallic) in organic synthesis.

11. Selective organic transformations – chemoselectivity, regioselectivity, steroselectivity, enatioselectivity. Protecting groups.

12. Physical characterization of organic compounds by IR, UV-, MS and NMR.

13. Principles related to Practical Chemistry.

Physics Syllabus

1. (a) Mechanics of Particles: Cartesian and Spherical polar co-ordinate systems; area, volume, displacement, velocity and acceleration in these systems. Laws of motion; conservation of energy and momentum, applications to rotating frames, centripetal and Coriolis accelerations; Motion under a central force; Conservation of angular momentum, Kepler's laws; Fields and potentials; Gravitational field and potential due to spherical bodies, Gauss and Poisson equations, gravitational self-energy; Two-body problem; Reduced mass; Rutherford scattering; Centre of mass and laboratory reference frames.

(b) Mechanics of Rigid Bodies: System of particles; Centre of mass, angular momentum, equations of motion; Conservation theorems for energy, momentum and angular momentum; Elastic and inelastic collisions; Rigid body; Degrees of freedom, Euler's theorem, angular velocity, angular momentum, moments of inertia, theorems of parallel and perpendicular axes, equation of motion for rotation; Molecular rotations (as rigid bodies); Di and tri-atomic molecules; Precessional motion; top, gyroscope.

(c) Mechanics of Continuous Media: Elasticity, Hooke's law and elastic constants of isotropic solids and their inter-relation; Streamline (Laminar) flow, viscosity, Poiseuille's equation, Bernoulli's equation, Stokes' law and applications.

(d) Special Relativity: Michelson-Morley experiment and its implications; Lorentz transformations-length contraction, time dilation, addition of relativistic velocities, aberration and Doppler effect, mass-energy relation, simple applications to a decay process; Four dimensional momentum vector; Covariance of equations of physics.

2. OSCILLATIONS,Waves and Optics:

(a)Damped Oscillations: Superposition of two SHM by vector addition, superposition of two perpendicular SHM, Polarization, Lissajous figures– superposition of many SHMs, complex number notation and use of exponential series. Damped motion of mechanical and electrical oscillator, heavy damping,

critical damping. Damped single harmonic oscillator, amplitude decay, logarithmic decrement, relaxation time, energy decay, Q value, rate of energy decay equal to work rate of damping force, problems.

Forced Oscillations: Transient and steady state behaviour of a forced oscillator, Variation of displacement and velocity with frequency of driving force, frequency dependence of phase angle between force and (a) displacement, (b) velocity, Vibration Insulation – Power supplied to oscillator, Q-value as a measure of power absorption

bandwidth, Q-value as amplification factor of low frequency response, modes of vibration, inductance coupling of electrical oscillators, wave motion as the limit of coupled oscillations.

(b)Wave Motion: The wave equation, transverse waves on a string , the string as a forced oscillator, characteristic impedance of a string, reflection and transmission of transverse waves at a boundary , impedance matching, insertion of quarter wave element, standing waves on a string of fixed length, normal modes and eigen frequencies. Energy in a normal mode of oscillation, wave groups, group velocity, dispersion, wave group of many components, bandwidth theorem, transverse waves in a periodic structure (crystal). Doppler effect, sound waves in gases, energy distribution in sound waves, intensity, specific acoustic impedance, longitudinal waves in a solid, Young's modulus, Poisson's ratio, longitudinal waves in a periodic structure, reflection and transmission of sound waves..

(c) Geometrical Optics: Laws of reflection and refraction from Fermat's principle; Matrix method in paraxial optics-thin lens formula,mirror formula, nodal planes, system of two thin lenses, chromatic and spherical aberrations.

(d) Interference: Interference of light-Young's experiment, Newton's rings, interference by thin films, Michelson interferometer; Multiple beam interference and Fabry-Perot interferometer. Anti reflection coatings.

(e) Diffraction: Fraunhofer diffraction-single slit, double slit, diffraction grating, resolving power; Diffraction by a circular aperture and the Airy pattern; Fresnel diffraction: half-period zones and zone plates, circular aperture.

(f) Polarization and Modern Optics: Production and detection of linearly and circularly polarized light; Double refraction, quarter wave plate; Optical activity; Principles of fibre optics, attenuation; Pulse dispersion in step index and parabolic index fibres; Material dispersion, single mode fibres; Lasers-Einstein A and B coefficients; Ruby and He-Ne lasers; Characteristics of laser light-spatial and temporal coherence; Focusing of laser beams; Three-level scheme for laser operation; Holography and simple applications.

(g) Laser: Spontaneous and stimulated emission, population inversion, resonator, Helium-Neon laser, fluorescence and phosphorescence.

3. Electricity and Magnetism:

(a)Calculus of Vectors : Introduction to gradient, divergence & curl; their physical significance. Rules for vector derivatives, useful relations involving gradient, divergence & curl. Fundamental theorem for gradients, Gauss's and Stoke's theorems

(b) Electrostatics and Magnetostatics: Electric charge and its properties, Coulomb's law. The electric field due to a point charge and continuous charge distributions, Field due to electric dipole, Field lines, flux, Gauss's law and its applications. Curl of electric field. Relation between potential and electric field .Laplace and Poisson equations in electrostatics and their applications; Electric potential due to different charge distribution: Wire, Ring, Disc, Spherical Sheet, Sphere, dipole etc. The energy for a point and continuous charge distribution. Conductors in the electrostatic field, Capacitors, Current and current density, drift velocity, expression for current density vector, equation of continuity. Ohm's Law and expression for electrical conductivity, limitations of Ohm's law. Equipotential surface method of electrical images.. Energy of a system of charges, multipole expansion of scalar potential; Method of images and its applications; Potential and field due to a dipole, force and torque on a dipole in an external field; Dielectrics, polarization; Solutions to boundary-value problems-conducting and dielectric spheres in a uniform electric field;

Magnetic fields, magnetic forces, magnetic force on a current carrying wire. Torque on a current loop, Biot-Savart law . Field due to infinite wire carrying steady current, field of rings and coils. Magnetic field due to a solenoid, Force on parallel current carrying wires. Ampere's circuital law and its applications to infinite hollow cylinder, solenoid and toroid. The divergence and curl of **B**. Comparison of magnetostatics and electrostatics. Magnetic vector potential and its expression. Surface current density and Change in magnetic field at a current sheet. Hall Effect .Magnetic shell, uniformly magnetized sphere; Ferromagnetic materials, hysteresis, energy loss.

(c) Current Electricity: Kirchhoff's laws and their applications; Biot-Savart law, Ampere's law, Faraday's law, Lenz' law; Self-and mutual-inductances; Mean and r m s values in AC circuits; DC and AC circuits with R, L and C components; Series and parallel resonances; Quality factor; Transformers,AC generator,DC generator,AC moter,DC moter.

(d) Electromagnetic Waves and Blackbody Radiation: Displacement current and Maxwell's equations; Wave equations in vacuum, Poynting theorem; Vector and scalar potentials; Electromagnetic field tensor, covariance of Maxwell's equations; Wave equations in isotropic dielectrics, reflection and refraction at the boundary of two dielectrics; Fresnel's relations; Total internal reflection; Normal and anomalous dispersion; Rayleigh scattering; Blackbody radiation and Planck's radiation law, Stefan- Boltzmann law, Wien's displacement law and Rayleigh-Jeans' law. E.M waves and communication.

4. Thermal and Statistical Physics:

(a) Thermodynamics: Laws of thermodynamics, reversible and irreversible processes, entropy; Isothermal, adiabatic, isobaric, isochoric processes and entropy changes; Otto and Diesel engines, Gibbs' phase rule and chemical potential; van der Waals equation of state of a real gas, critical constants; Maxwell-Boltzman distribution of molecular velocities, transport phenomena, equipartition and virial theorems; Dulong-Petit, Einstein, and Debye's theories of specific heat of solids;

Maxwell relations and applications; Clausius- Clapeyron equation; Adiabatic demagnetisation, Joule-Kelvin effect and liquefaction of gases.

(b) Statistical Physics: The statistical basis of thermodynamics: Probability and thermodynamic probability; principle of equal a priori probabilities, probability distribution, its narrowing with increasing n, average properties, fluctuations,micro and macrostates, accessible and inaccessible states. Phase space, division of phase space into cells, Thermal equilibrium between two systems, beta parameter and its identification with (kT)-1, probability and entropy, Boltzmann's entropy relation, statistical interpretation of second law of thermodynamics. Maxwell-Boltzmann statistics, application of M-B statistics to monoatomic gas, principle of equipartition of energy, Bose-Einstein statistics, deduction of Planck's radiation law, derivation of Wiens's displacement law and Stefan's law. Fermi-Dirac statistics, comparison of three types of statistics

5. Quantum Mechanics: Wave-particle dualitiy; Schroedinger equation and expectation values; Uncertainty principle; Solutions of the one-dimensional Schroedinger equation for a free particle (Gaussian wave-packet), particle in a box, particle in a finite well, linear harmonic oscillator; Reflection and transmission by a step potential and by a rectangular barrier; Particle in a three dimensional box, density of states, free electron theory of metals; Angular momentum; Hydrogen atom; Spin half particles, properties of Pauli spin matrices.

6. Atomic and Molecular Physics: Stern-Gerlach experiment, electron spin, fine structure of hydrogen atom; L-S coupling, J-J coupling; Spectroscopic notation of atomic states; Zeeman effect; Frank- Condon principle and applications; Elementary theory of rotational, vibratonal and electronic spectra of diatomic molecules; Raman effect and molecular structure; Laser Raman spectroscopy; Importance of neutral hydrogen atom, molecular hydrogen and molecular hydrogen ion in astronomy; Fluorescence and Phosphorescence; Elementary theory and applications of NMR and EPR; Elementary ideas about Lamb shift and its significance.

7. Nuclear and Particle Physics: Basic nuclear properties-size, binding energy, angular momentum, parity, magnetic moment; Semi-empirical mass formula and applications, mass parabolas; Ground state of deuteron, magnetic moment and non-central forces; Meson theory of nuclear forces; Salient features of nuclear forces; Shell model of the nucleus - successes and limitations; Violation of parity in beta decay; Gamma decay and internal conversion; Elementary ideas about Mossbauer spectroscopy; Q-value of nuclear reactions; Nuclear fission and fusion, energy production in stars; Nuclear reactors. Classification of elementary particles and their interactions; Conservation laws; Quark structure of hadrons; Field quanta of electroweak and strong interactions; Elementary ideas about unification of forces; Physics of neutrinos.

8. Solid State Physics, Devices and Electronics: Crystalline and amorphous structure of matter; Different crystal systems, space groups; Methods of determination of crystal structure; X-ray diffraction, scanning and transmission electron microscopies; Band theory of solids - conductors, insulators and semiconductors; Thermal properties of solids, specific heat, Debye theory; Magnetism: dia, para and ferromagnetism; Elements of superconductivity, Meissner effect, Josephson junctions and applications; Elementary ideas about high temperature superconductivity. Intrinsic and extrinsic semiconductors; pn- p and n-p-n transistors; Amplifiers and oscillators; Op-amps; FET, JFET and MOSFET; Digital electronics-Boolean identities, De Morgan's laws, logic gates and truth tables; Simple logic circuits; Thermistors, solar cells; Fundamentals of microprocessors and digital computers.`

Zoology

Unit I Diversity in Living World

- **Biology** – it's meaning of relevance to mankind.
- **Taxonomy** – Concept of species and taxonomical hierarchy.
- **Kingdom Animalia** - Salient features (In the reference to habitat, habits morphology and economic importance) and classification of non chordates up to phylum level.
  Salient features (In the reference to habitat, habits, morphology and economic importance) classification of chordates up to class level.

Unit II Structural organization in Animals

- Tissue in animals
- Morphology, anatomy and function of different systems (digestive, circulatory respiratory nervous and reproductive) of earthworm, frog and an insect (Cockroach)

Unit III Animal Physiology

Human Physiology

Digestion and absorption – Alimentary canal and digestive glands, role of digestive enzymes and gastrointestinal hormones , digestion, absorption and assimilation of proteins carbohydrates and fats, egestion, nutrition and digestive disorders.
Breathing and respiration – Respiratory organs in human beings, Mechanism of Breathing and it's regulation in human, Transport of respiratory gases, Respiratory volumes. Respiratory disorders.
Circulation
Composition of Blood, Blood groups, coagulation of blood, composition of lymph and its functions, structure of human heart and blood vessels, Cardiac cycle, Cardiac output, ECG, double circulation. Disorders of circulatory systems.
Excretion – Modes of excretion, structure and function of excretory system, Urine formation, osmoregulation, Regulation of kidney function, Renin- angiotensin, role of other organs in excretion, Disorders of excretory system.

- **Locomotion and Movement** – Types of movement, skeletal muscle- contractile proteins and muscle contraction, skeletal system and its function, joints. Disorders of muscular and skeletal system.
- **Neural control and coordination** – Neuron and nerves; Nervous system in humans- central nervous system, peripheral nervous system and visceral nervous system; Generation and conduction of nerve impulse; Reflex action ; Sense organs; Elementary structure and function of eye and ear.
- **Chemical coordination and regulation** – endocrine glands and hormones; Human endocrine system- Hypothalamus, Pituitary, Pineal, Thyroid, Parathyroid, Adrenal, Pancreas, Gonads; Mechanism of hormone action (Elementary idea); Role of hormones as messengers and regulators , Hypo-and hyperactivity and related disorders (Common disorders e'g Dwarfism)

Unit IV Reproduction

Human Reproduction- Male and female reproductive systems; Microscopic anatomy of testis and ovary; Gametogenesis-spermatogenesis and oogenesis; Menstrual cycle; fertilistion, embryo development up to blastocyst formation, implantation; Pregnancy and placenta formation (Elementary idea); Parturition (Elementary idea); Lactation (Elementary idea).

Reproductive health- Need for reproductive health and prevention of sexually transmitted diseases (STD); Birth control-Ned and Methods, Contraception and Medical Termination of Pregnancy (MTP); amniocentesis; Infertility and assisted reproductive technologies- IVF, ZIFT, GIFT (Elementary idea for general awareness).

Unit V Cell biology, genetics and Evolution

Structure and function of bio molecules : Carbohydrates, lipids proteins, and nucleic acid.
Enzymes-types,properties,functions and enzymes action
Cell-physico-chemical nature of plasma membrane, cell wall.
Ultra structure of cell organelles with brief

1. Endoplasmicreticulum, golgibodies, lysosome, vacuoles, mitochondria, ribosomes, plastids, cilia, flagella, centrioles nucleolus.
2. Cell division : cell cycle, mitosis , meiosis and their significance.

Heredity and variation: Mendelian Inheritance; Deviations from Mendelism-Incomplete dominance, Co-dominance, Multiple alleles and Inheritance of blood groups, Pleiotropy; Elementary idea of polygenic inheritance; Chromosome theory of inheritance; Chromosomes and genes: Sex determination-In humans, birds, honey bee; Linkage and crossing over; Sex linked inheritance-Haemophilia, Colour blindness; Mendelian disorders in humans-Thalassemia; Chromosomal disorders in humans; Down's syndrome, Turner's and Klinefelter's syndromes.

Molecular basis of Inheritance: Search for genetic material and DNA as genetic material; Structure of DNA and RNA; DNA packaging; DNA replication; Central dogma: Transcription, genetic code, translation; Gene expression and regulation-Lac Operon; Genome and human genome project; DNA finger printing.

Evolution: Origin of life; Biological evolution and evidences for biological evolution from Paleontology, comparative anatomy, embryology and molecular evidence); lamarcks theory of evolution Darwin's contribution, Modern Synthetic theory of Evolution; Mechanism of evolution-Variation (Mutation and Recombination) and Natural Selection with examples, types of natural selection; Gene flow and genetic drift; Hardy-Weinberg's principle; daptive Radiation; Human evolution.

UNIT VI Biology and Human Welfare

Health and Disease; Pathogens; parasites causing human diseases (Malaria, Filariasis, Ascariasis, Typhoid, Pneumonia, common cold, amoebiasis, ring worm); Basic concepts of immunology-vaccines; Cancer, HIV and AIDS; Adolescence, drug and alcohol abuse.

Improvement in food production:Plant breeding, tissue culture, single cell protein, Biofortification; Apiculture and Animal husbandry.

Microbes in human welfare: In household food processing, industrial production, sewage treatment, energy generation and as biocontrol agents and biofertilizers.

UNIT VII Biotechnology and Its Applications

-Principles and process of Biotechnology: Genetic engineering (Recombinant DNA technology).

-Application of Biotechnology in health and agriculture: Human insulin and vaccine production,gene therapy; Genetically modified organisms-Bt crops; Transgenic Animals; Biosafety issues-Biopiracy and patents.

UNIT VIII Ecology and environment

-Organisms and environment: Habitat and niche; Population and ecological adaptations; Population interactions-mutualism, competition, predation, parasitism; Population attributes-growth, birth rate and death rate, age distribution.

-Ecosystem: Patterns, components; productivity and decomposition; Energy flow; Pyramids of number,biomass, energy; Nutrient cycling (carbon and phosphorous); Ecological succession; Ecological Services-Carbon fixation, pollination, oxygen release.Biogeochemical cycle

-Biodiversity and its conservation: Concept of Biodiversity; Patterns of Biodiversity; Importance of Biodiversity; Loss of Biodiversity; Biodiversity conservation; Hotspots, endangered organisms, extinction.Red Data Book, biosphere reserves, National parks and sanctuaries.

-Environmental issues: Air pollution and its control; Water pollution and its control; Agrochemicals and their effects; Solid waste management; Radioactive waste management; Greenhouse effect and global warning; Ozone depletion; Deforestation; Any three case studies as success stories addressing environmental issues.

Botany

Unit I Diversity in Living World

- **Biology** – it's meaning of relevance to mankind.
- **Taxonomy** – Concept of species and taxonomical hierarchy.
- **Systematic** - Introduction to plant Systematic, its aims, objectives and importance, classification, brief history, introduction, various systems of classification of living organism (Two kingdom system, five kingdom system) Brief introduction to nomenclature and binomial system of nomenclature.
- **Salient features and classification of kingdom Monera** – (Including Archaebacteria and cyno bacteria) General structure, occurrence, reproduction and economic importance.
- **Kingdom protista** – General structure, occurrence, reproduction and economic importance.
- **Kingdom Fungi** – General structure, occurrence, reproduction and economic importance, diseases of economically important crop plant, rusts, smuts, downy and powdery mildew damping off.
- **Kingdom Plantae** – Salient features and classification of plants into major groups
  Algae - General account, structure, life cycle and economic importance of liverworts and mosses.
- **Pteridophytes** – General account, structure, classification, life cycle and economic importance.
- **Gymnosperms** – General account, structure, classification, life cycle and economic importance.
- **Angiosperms** – Classification up to class, General account, structure, life cycle and economic importance.
  Viruses – General structure, types and reproduction of viruses.
  Lichens – General account, structure and life history.

Unit II Structural organization in plants

- **Tissue** , Tissue system in plants
- **Morphology**, faction and modification of root, stem and leaf.
- **Anatomy** of roots, stem and leaf, primary and secondary growth in dicot stem.
- Inflorescence, Types of Inflorescence, flower (including postion and arrangement of different whorls) placentation , fruit, types of fruit, seed.
- Diagnostics features, economic importance and distribution pattern of Angiospermic families
  A) Family Brassicaceae
  B) Family Fabaceae
  C) Family SOlnaceae
  D) Family Liliaceae
  E) Family Poaceae

Unit III Plant Physiology

- **Transport in Plants-** Movement of water (including diffusion, osmosis, plasmolysis and water relation of cell and nutrients, long distant of water – absorption, apoplast, symplast, transpiration pull, root pressure and guttation, transpiration opening and closing of stomata, uptake and translocation of mineral nutrients – Transport of food, phloem transport, mass flow hypothesis.
- **Mineral Nutrition-** Essential minerals, macro and micro nutrients and their role, deficiency symptons, Mineral toxicity, Elementary idea of hydroponics as a method to study mineral nutrition .
- **Nitrogen Metabolism** – Biological nitrogen fixation, Nitrogen cycle.
- **Photosynthesis** – Photosynthesis as means of autotrophic nutrition, pigments involved in Photosynthesis, absorption and action spectra, photochemical and biosynthetic phases of Photosynthesis , photophosphorylation : cycle and non cyclic of photophosphorylation , chemiosmotic hypothesis, photorespiration, factors affecting Photosynthesis.
- **Respiration** – Aerobic respiration : Glycolysis; Kerb's cycle Electron transport chain and oxidative phosphoryation Anaerobic respiration, respiratory substance and respiratory quotient.
- **Plant Growth and development** – Phases of plant growth and plant rate, condition of growth , Differentiation and dedifferentiation, Dedifferentiation Growth regulators – Role of auxins, gibberdlin, cytokinen, ethylene, abscissic acid photoperiodism, role of phytochrome and hormones in photoperiodism, Dormancy, methods of breaking seed dormancy, verbalization.
- **Plant movements** – Tropic movements, phototropism, gravitropism and their mechanism, Nastic movements.

Unit IV Reproduction

Reproduction in organisms – Reproduction, a characteristic feature of all organism for continuation of species; Modes of reproduction – Asexual and sexual; Asexual reproduction; Modes-Binary fission, speculation, budding gemmule, fragmentation; vegetative propagation in plants.

Sexual reproduction in flowering plants- Flower structure; development of male and female gametophytes; Pollination-types, agencies and examples; Out breeding devices; Pollen-Pistil interaction; Double fertilization; Post fertilization events-Development of endosperm and embryo, Development of seed and formation of fruit; special modes-apomixis, parthenocarpy polyembryony; Significance of seed and fruit formation.

Unit V Cell biology, genetics and evolution

Structure and function of bio molecules : Carbohydrates,lipids proteins, and nucleic acid.
Enzymes-types,properties,functions and enzymes action
Cell-physico-chemical nature of plasma membrane, cell wall.
Ultra structure of cell organelles with brief

1. Endoplasmicreticulum, golgibodies, lysosome, vacuoles, mitochondria, ribosomes, plastids, cilia, flagella, centrioles nucleolus.
2. Cell division : cell cycle, mitosis , meiosis and their significance.

Heredity and variation: Mendelian Inheritance; Deviations from Mendelism-Incomplete dominance, Co-dominance, Multiple alleles, Pleiotropy; Elementary idea of polygenic inheritance; Chromosome theory of inheritance; Chromosomes and genes.

Molecular basis of Inheritance: Search for genetic material and DNA as genetic material; Structure of DNA and RNA; DNA packaging; DNA replication; Central dogma; Transcription, genetic code, translation; Gene expression and regulation.

Evolution: Origin of life; Biological evolution and evidences for biological evolution from Paleontology, comparative anatomy, embryology and molecular evidence); lamarcks theory of evolution Darwin's contribution, Modern Synthetic theory of Evolution; Mechanism of evolution-Variation (Mutation and Recombination) and Natural Selection with examples, types of natural selection; Gene flow and genetic drift; Hardy-Weinberg's principle; Adaptive Radiation; Human evolution.

UNIT VI Biology and Human Welfare

Improvement in food production; Plant breeding, tissue culture, single cell protein, Biofortification; Apiculture and Animal husbandry.

UNIT VII Biotechnology and Its Applications

-Principles and process of Biotechnology: Genetic engineering (Recombinant DNA technology).

-Application of Biotechnology in health and agriculture: Human insulin and vaccine production,gene therapy; Genetically modified organisms-Bt crops; Transgenic Animals; Biosafety issues-Biopiracy and patents.

UNIT VIII Ecology and environment

-Organisms and environment: Habitat and niche; Population and ecological adaptations; Population interactions-mutualism, competition, predation, parasitism; Population attributes-growth, birth rate and death rate, age distribution.

-Ecosystem: Patterns, components; productivity and decomposition; Energy flow; Pyramids of number, biomass, energy; Nutrient cycling (carbon and phosphorous); Ecological succession; Ecological Services-Carbon fixation, pollination, oxygen release. Biogeochemical cycle

-Biodiversity and its conservation: Concept of Biodiversity; Patterns of Biodiversity; Importance of Biodiversity; Loss of Biodiversity; Biodiversity conservation; Hotspots, endangered organisms, extinction, Red Data Book, biosphere reserves, National parks and sanctuaries.

-Environmental issues: Air pollution and its control; Water pollution and its control; Agrochemicals and their effects; Solid waste management; Radioactive waste management; Greenhouse effect and global warning; Ozone depletion; Deforestation; Any three case studies as success stories addressing environmental issues.

SYLLABUS FOR MATHEMATICAL SCIENCES (FGT)

Matrices & Determinant:

Concept, notation, order, equality, types of matrices, zero matrix, transpose of a matrix, symmetric and skew symmetric matrices. Addition, multiplication and scalar multiplication of matrices, simple properties of addition, multiplication and scalar multiplication. Non-commutativity of multiplication of matrices and existence of non-zero matrices whose product is the zero matrix (restrict to square matrices of order 2). Concept of elementary row and column operations. Invertible matrices and proof of the uniqueness of inverse, if it exists.

Determinant of a square matrix (up to 3□3matrices), properties of determinants, minors, cofactors and applications of determinants in finding the area of a triangle.

Adjoint and inverse of a square matrix. Consistency, inconsistency and number of solutions of system of linear equation by examples, solving system of linear equations in two or three variables using inverse of a matrix. Rank and determinant of matrices, linear equations. Eigen values and eigen vectors, Cayley-Hamilton theore

Elementary set theory, Sets:

Sets

Sets and their representations. Empty set, Finite & Infinite sets, Equal sets. Subsets, Subsets of the set of real numbers especially intervals (with notations). Power set. Universal set. Venn diagrams. Union and Intersection of sets. Difference of sets. Complement of a set, Properties of complement sets. Some basic notation of set theory, countable and uncountable sets. Supremum and infimum of a set. Elements of point set theory including properties of open, closed and compact sets in

Sequence and series:

Sequence and Series, Arithmetic Progression (A.P), Arithmetic Mean (A.M), Geometric Progression (G.P), general term of a G.P, sum of n terms of a G.P . Arithmetic and Geometric series, infinite G.P. and its sum. Geometric mean (G .M), relation between A.M and G.M, Sum to n term of the special series $\sum n$,.$\sum n^2$ and $\sum n^3$. Convergence,. Sequences and series of functions, uniform convergence.

Binomial Theorem:

History, statement and proof of the binomial theorem for positive integral indices. Pascal's triangle, general and middle term in binomial expansion, simple applications. Bolzano Weierstrass theorem, Heine Borel theorem.

Continuity and Differentiability:

Continuity, uniform continuity. Continuity and Differentiability, derivative of composite functions, chain rule, derivative of inverse trigonometric functions, derivative of implicit function.

Concepts of exponential and logarithmic functions. Derivatives of $\log e^x$ and e^x. Logarithmic differentiation. Derivative of functions expressed in parametric forms.

Second order derivatives. Rolle's and Lagrange's Mean Value Theorems (without proof) and their geometric interpretations.

Applications of Derivatives:

Applications of derivatives: rate of change, increasing/decreasing functions, tangents and normal, approximation, maxima and minima. Simple problems (that illustrate basic principles and understanding of the subject as well as real life situations).

Limits and Derivatives:

Derivative introduced as rate of change both as that of distance function and geometrically, intuitive idea of limit. , limsup, liminf . Definition of derivative, relate it to slope of tangent of the curve, derivative of sum, difference, product and quotient of functions. Derivatives of polynomial and trigonometric functions. Mean value theorem.

Integrals: Integration as inverse process of differentiation. Integration of a variety of functions by substitution, by partial fractions and by parts. Definite integrals as a limit of a sum. Fundamental Theorem of Calculus, Basic properties of definite integrals and evaluation of definite integrals. Double and Triple Integrals, Change of variables. Applications to evaluation of areas, Volume, Centre of Gravity and Moments of Inertia etc. Change of order of integration in double integrals

Differential Equations

Exact differential equations. First order and higher degree equations solvable for x,y,p. Clairaut's form and singular solutions. Geometrical meaning of a differential equation. Orthogonal trajectories. Linear differential equations with constant and variable coefficients. Variation of Parameters method, reduction method, series solutions of differential equations. Power series method, Bessel and Legendre equations. (only series solution).

Vector spaces: Vectors and scalars, magnitude and direction of a vector. Direction cosines/ratios of vectors. Types of vectors (equal, unit, zero, parallel and collinear vectors), position vector of a point, negative of a vector, components of a vector, addition of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio. Scalar (dot) product of vectors, projection of a vector on a line. Vector (cross) product of vectors, scalar triple product.

Linear Inequalities:

Linear inequalities, Algebraic solutions of linear inequalities in one variable and their representation on the number line. Graphical solution of linear inequalities in two variables. Solution of system of linear inequalities in two variables - graphically.

Subspaces, linear dependence, basis, dimension, algebra of linear transformations.

Straight Lines :

Brief recall of 2-D from earlier classes, Shifting of origin. Slope of a line and angle between two lines .Various forms of equations of a line: parallel to axes, point–slope form, slop–intercept form, two–point form, intercept form and normal form, General equation of a line. Equation of family of lines passing through the point of intersection of two lines. Distance of a point from a line.

Conic Sections:

Sections of a cone ; circles , ellipse , parabola, hyperbola ,a point , a straight line and a pair of intersecting lines as a degenerated case of a conic section. Standard equations and simple properties of parabola, ellipse and hyperbola. Standard equations of a circle.

Introduction to Three-dimensional Geometry:

Coordinate axes and coordinate planes in three dimensions. Coordinates of a point. Distance between two points and section formula.

Three-dimensional Geometry:

Direction cosines/ratios of a line joining two points. Cartesian and vector equation of a line, coplanar and skew lines, shortest distance between two lines. Cartesian and vector equation of a plane. Angle between (i) two lines, (ii) two planes, (iii) a line and a plane. Distance of a point from a plane.

Complex Numbers and Quadratic Equations:

Need for complex numbers, especially $\sqrt{-1}$, to be motivated by inability to solve every quadratic equation. Brief description of algebraic properties of complex numbers. Argand plane and polar representation of complex numbers. Statement of Fundamental Theorem of Algebra, solution of quadratic equations in the complex number system. Square-root of a Complex number.

Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions.

Trigonometric Functions:

Positive and negative angles. Measuring angles in radians and in degrees and conversion from one measure to another. Definition of trigonometric functions with the help of unit circle. Truth of the identity $\sin^2 x + \cos^2 x = 1$, for all x. Signs of trigonometric functions and sketch of their graphs. Expressing $\sin(x \pm y)$ and $\cos(x \pm y)$ in terms of sinx, siny, cosx & cosy.
Identities related to sin 2x, cos 2x, tan 2x, sin 3x, cos 3x and tan 3x. General solution of trigonometric equations of the type $\sin\theta = \sin\alpha$, $\cos\theta = \cos\alpha$ and $\tan\theta = \tan\alpha$.

Limit and Continuity

Limit and Continuity of functions of two variables. Partial differentiation. Change of variables. Partial derivation and differentiability of real–valued functions of two variables. Schwartz's and Young's Theorem. Statements of Inverse and implicit function theorems and applications. Euler's theorem on homogeneous functions. Taylor's theorem for functions of two variables. Jacobins.

Permutations & Combinations:

Fundamental principle of counting, Factorial n(n!) Permutations and combinations, derivation of formulae and their connections, simple applications. Pigeon-hole principle, inclusion-exclusion principle.

Fundamental theorem of arithmetic, divisibility in Z, congruences, Chinese Remainder Theorem, Euler's Ø- function, primitive roots.

Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems.
Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain.

Numerical Analysis:

Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

Number Theory
The division algorithm, The greatest common divisor, least common multiple, The Euclidean alogrithm, The Diophantine equation $ax + by = c$ Prime numbers and their distribution, The fundamental theorem of arithmetic, Basic properties of congruences, Linear congruences, Special divisibility tests.

Mathematical Reasoning:

Mathematically acceptable statements. Connecting words/phrases–consolidating the understanding of "if and only if (necessary and sufficient) condition", " implies", "and/or", "implied by", "and", "or", there exists" and their use through variety of examples related to real life and Mathematics , Validating the statements involving the connecting words- difference between contradiction, converse and contrapositive.

Statistics:

Measure of dispersion: mean deviation, variance and standard deviation of ungrouped/grouped data. Analysis of frequency distributions with equal means but different variances.

Probability:

Random experiments: outcomes, sample spaces(set representation). Events: Occurrence of events, 'not', 'and' & 'or' events, exhaustive events, mutually exclusive events. Axiomatic (set theoretic) probability, connections with the theories of earlier classes.

Probability of an event, probability of 'not', 'and' & 'or' events. Multiplication theorem on probability. Conditional probability, independent events, total probability, Baye's theorem, Random variable and its probability distribution, mean and variance of haphazard variable. Repeated independent (Bernoulli) trials and Binomial distribution. Sample space, discrete

probability, independent events, Bayes theorem. Random variables and distribution functions (uni- variate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Probability inequalities (Tchebyshef, Markov, Jensen). Modes of convergence, weak and strong laws of large numbers, Central Limit theorems .

Linear Programming Problem:

Introduction, definition of related terminology such as constraints, objectives function, optimization, different types of linear programming (L.P.) problems, mathematical formulation of L.P problems, graphical method of solution for problems in two variables, feasible and infeasible regions, feasible and infeasible solutions, optimal feasible solutions (up to three non-trivial constrains)

Statics: Basic notation, Newton Laws of motion, system of two forces, parallelogram law of forces, resultant of two collinear forces, resolution of forces, moment of a force, couple, theorem on moments of a couple, coplaner forces, resultant of three coplanar concurrent forces, theorem of resolved parts, resultant of two forces acting on a rigid body, Varignon's theorem, generalized theorem of moments.

Equilibrium

Equilibrium of two concurrent forces, equilibrium condition for any number of coplanar concurrent forces, Lami's theorem. λ - μ theorem, theorems of moments, resultant of a force and a copule. Equilibrium conditions for coplanar non-concurrent forces.

Dynamics:

Motion of a particle with constant acceleration , acceleration of falling bodies, motion under gravity, motion of a body projected vertically upward, motion of a two particles connected by a string, motion along a smooth inclined plane, constrained motion along a smooth inclined plane. Variable acceleration: Simple harmonic motion, elastic string. curvilinear in a plane, Definition of velocity and acceleration , Projectile, motion in a circle, motion under constraints, central force motion