SYLLABUS FOR PUCAT-2025

Bachelor of Science (B. Sc.)

For Admission to: B. Sc. (Zoology, Botany, Chemistry, Environmental Science, Physics, Maths, Chemistry, Geology, Microbiology)

Question Paper Pattern (All Parts are Compulsory)	Time: 02 Hours	Physics	Chemistry	Mathematics/Biology
	Total: 100 MCQs	**30**	**30**	**40**

Syllabus

BIOLOGY

Diversity of Living Organisms: The Living World What is living? Biodiversity; Need for classification; three domains of life; concept of species and taxonomical hierarchy; binomial nomenclature. **Biological Classification:** Five kingdom classification, Salient features and classification of Monera, Protista and Fungi into major groups; Lichens, Viruses and Viroids.
Plant Kingdom: Salient features and classification of plants into major groups - Algae, Bryophyta, Pteridophyta and Gymnospermae. (salient and distinguishing features and a few examples of each category). **Animal Kingdom:** Salient features and classification of animals, non-chordates up to phyla level and chordates up to class level (salient features and distinguishing features of a few examples of each category). (No live animals or specimen should be displayed.)

Structural Organization in Animals and Plants: Morphology of Flowering Plants; Morphology of inflorescence and flower, Description of 01 family; Solanaceae or Liliaceae (to be dealt along with the relevant experiments of the Practical Syllabus). **Structural Organization in Animals;** Animal tissues.

Cell: Structure and Function
Cell-The Unit of Life Cell theory and cell as the basic unit of life, structure of prokaryotic and eukaryotic cells; Plant cell and animal cell; cell envelope; cell membrane, cell wall; cell organelles - structure and function; endomembrane system, endoplasmic reticulum, golgi bodies, lysosomes, vacuoles, mitochondria, ribosomes, plastids, microbodies; cytoskeleton, cilia, flagella, centrioles (ultrastructure and function); nucleus.
Biomolecules: Chemical constituents of living cells: biomolecules, structure and function of proteins, carbohydrates, lipids, nucleic acids; Enzymes- types, properties, enzyme action.
Cell Structure and Function: Cell Cycle and Cell Division; Cell cycle, mitosis, meiosis and their significance.

Plant Physiology: Photosynthesis in Higher Plants; Photosynthesis as a means of autotrophic nutrition; site of photosynthesis, pigments involved in photosynthesis (elementary idea); photochemical and biosynthetic phases of photosynthesis; cyclic and non-cyclic photophosphorylation; chemiosmotic hypothesis; photorespiration; C3 and C4 pathways; factors affecting photosynthesis.
Respiration in Plants; Exchange of gases; cellular respiration - glycolysis, fermentation (anaerobic), TCA cycle and electron transport system (aerobic); energy relations - number of ATP molecules generated; amphibolic pathways; respiratory quotient. **Plant - Growth and Development** Growth regulators - auxin, gibberellin, cytokinin, ethylene, ABA.

Human Physiology

Breathing and Exchange of Gases Respiratory organs in animals (recall only); Respiratory system in humans; mechanism of breathing and its regulation in humans - exchange of gases, transport of gases and regulation of respiration, respiratory volume; disorders related to respiration - asthma, emphysema, occupational respiratory disorders. **Body Fluids and Circulation;** Composition of blood, blood groups, coagulation of blood; composition of lymph and its function; human circulatory system - Structure of human heart and blood vessels; cardiac cycle, cardiac output, ECG; double circulation; regulation of cardiac activity; disorders of circulatory system - hypertension, coronary artery disease, angina pectoris, heart failure. **Excretory Products and their Elimination;** Modes of excretion - ammonotelism, ureotelism, uricotelism; human excretory system – structure and function; urine formation, osmoregulation; regulation of kidney function - renin - angiotensin, atrial natriuretic factor, ADH and diabetes insipidus; role of other organs in excretion; disorders - uremia, renal failure, renal calculi, nephritis; dialysis and artificial kidney, kidney transplant. **Locomotion and Movement;** Skeletal muscle, contractile proteins and muscle contraction. **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. **Chemical Coordination and Integration;** 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; dwarfism, acromegaly, cretinism, goiter, exophthalmic goiter, diabetes, Addison's disease.

Reproduction

Sexual Reproduction in Flowering Plants; Flower structure; development of male and female gametophytes; pollination - types, agencies and examples; outbreeding 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 dispersal and fruit formation. **Human Reproduction;** Male and female reproductive systems; microscopic anatomy of testis and ovary; gametogenesis - spermatogenesis and oogenesis; menstrual cycle; fertilisation, embryo development upto 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 (STDs); birth control - need and methods, contraception and medical termination of pregnancy (MTP); amniocentesis; infertility and assisted reproductive technologies - IVF, ZIFT, GIFT (elementary idea for general awareness).

Genetics and Evolution

Principles of Inheritance and Variation; 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 human being, birds and 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, Human and rice genome projects; DNA fingerprinting.

Biology and Human Welfare

Human Health and Diseases; Pathogens; parasites causing human diseases (malaria, dengue, chikungunya, filariasis, ascariasis, typhoid, pneumonia, common cold, amoebiasis, ring worm) and their control; Basic concepts of immunology - vaccines; cancer, HIV and AIDS; Adolescence

- drug and alcohol abuse. **Microbes in Human Welfare;** Microbes in food processing, industrial production, sewage treatment, energy generation and microbes as bio-control agents and bio-fertilizers. Antibiotics; production and judicious use. Unit-IX Biotechnology and its Applications.

Biotechnology - Principles and Processes; Genetic Engineering (Recombinant DNA Technology). **Biotechnology and its Application;** Application of biotechnology in health and agriculture: Human insulin and vaccine production, stem cell technology, gene therapy; genetically modified organisms - Bt crops; transgenic animals; biosafety issues, biopiracy and patents.

Ecology and Environment

Organisms and Populations; 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. **Biodiversity and its Conservation;** Biodiversity - Concept, patterns, importance; loss of biodiversity; biodiversity conservation; hotspots, endangered organisms, extinction, Red Data Book, Sacred Groves, biosphere reserves, national parks, wildlife, sanctuaries and Ramsar sites.

PHYSICS

Physical World and Measurement

Physical World: Physics- scope and excitement, nature of physical laws, Physics, technology and society. Units and Measurements: Need for measurement, Units of measurement, Length, mass and time measurements, systems of units, SI units, fundamental and derived units, errors in measurement, significant figures, Dimensions of physical quantities, accuracy and precision of measuring instruments, dimensional analysis and its applications.

Kinematics

Motion in a Straight Line: Frame of reference, Motion in a straight line, Position-time graph, speed and velocity, uniform and non-uniform motion, average speed and instantaneous velocity, uniformly accelerated motion, Relations for uniformly accelerated motion, velocity-time and position-time graphs, Elementary concepts of differentiation and integration for describing motion. Motion in a Plane: Scalar and vector quantities, general vectors and their notations, equality of vectors, position and displacement vectors, multiplication of vectors by a real number, addition and subtraction of vectors, relative velocity, Unit vector, rectangular components, Scalar and Vector product of vectors, resolution of a vector in a plane, Motion in a plane, cases of uniform velocity and uniform acceleration, projectile motion, uniform circular motion.

Laws of Motion

Intuitive concept of force, Equilibrium of concurrent forces, Inertia, Newton's first, second and third law of motion, momentum, impulse, Law of conservation of linear momentum and its applications, Centripetal force, examples of circular motion, Static and kinetic friction, laws of friction, rolling friction, lubrication, Dynamics of uniform circular motion.

Work, Energy and Power

Work done by a constant force and a variable force, kinetic energy, motion in a vertical circle, work-energy theorem, power, elastic and inelastic collisions in one and two dimensions, Notion of potential energy, potential energy of a spring, conservative forces, conservation of mechanical energy, non-conservative forces.

Motion of System of Particles and Rigid Body

Centre of mass of a two-particle system, momentum conservation and centre of mass motion, Centre of mass of rigid body, rigid body rotation and equations of rotational motion, centre of

mass of uniform rod, Equilibrium of rigid bodies, Moment of force, torque, angular momentum, law of conservation of angular momentum and its applications, comparison of linear and rotational motions, Moment of inertia, values of moments of inertia for simple geometrical objects, Statement of parallel and perpendicular axes theorems and their applications, radius of gyration.

Gravitation

Kepler's laws of planetary motion, universal law of gravitation, Gravitational potential energy and gravitational potential, Acceleration due to gravity and its variation with altitude and depth, escape velocity, Geo-stationary satellites, orbital velocity of a satellite.

Properties of Bulk Matter

Mechanical Properties of Solids: Elastic behaviour, Hooke's law, Stress-strain relationship, bulk modulus, Young's modulus, shear modulus of rigidity, Poisson's ratio, elastic energy.

Mechanical Properties of Fluids: Pressure due to a fluid column, Pascal's law and its applications, Viscosity, Stokes' law, terminal velocity, streamline and turbulent flow, critical velocity, effect of gravity on fluid pressure, application of surface tension ideas to drops, Bernoulli's theorem and its applications, Surface energy and surface tension, angle of contact, excess of pressure across a curved surface, bubbles and capillary rise. Thermal Properties of Matter: Heat, temperature, thermal expansion, thermal expansion of solids, liquids and gases, specific heat capacity, Wein's displacement Law, Stefan's law, Cp, Cv -calorimetry, change of state- latent heat capacity, Heat transfer-conduction, convection and radiation, qualitative ideas of Blackbody radiation, anomalous expansion of water, thermal conductivity, Greenhouse effect.

Thermodynamics

Thermal equilibrium and definition of temperature, zeroth law, heat, work and internal energy, isothermal and adiabatic processes, Laws of thermodynamics, reversible and irreversible processes, Heat engine and refrigerator.

Behaviour of Perfect Gases and Kinetic Theory of Gases

Equation of state of a perfect gas, concept of mean free path, work done in compressing a gas, Kinetic interpretation of temperature, Kinetic theory of gases- assumptions, concept of pressure, Avogadro's number, RMS speed of gas molecules, degrees of freedom, law of equi-partition of energy and application to specific heat capacities of gases.

Oscillations and Waves

Oscillations: Periodic motion, time period, frequency, displacement as a function of time, periodic functions, Simple harmonic motion (S.H.M) and its equation, energy in S.H.M., phase, oscillations of a loaded spring- restoring force and force constant, Kinetic and potential energies, Free, forced and damped oscillations, simple pendulum derivation of expression for its time period, resonance. Waves: Wave motion, speed of travelling wave, Transverse and longitudinal waves, displacement relation for a progressive wave, fundamental mode and harmonics, Beats, principle of superposition of waves, reflection of waves, Doppler effect, standing waves in strings and organ pipes.

Units and Measurements

Need for measurement: Units of measurement; systems of units; SI units, fundamental and derived units. significant figures. Dimensions of physical quantities, dimensional analysis and its applications.

Oscillations

Periodic motion - time period, frequency, displacement as a function of time, periodic functions and their application. Simple harmonic motion (S.H.M) and its equations of motion; phase; oscillations of a loaded spring- restoring force and force constant; energy in S.H.M. Kinetic and potential energies; simple pendulum derivation of expression for its time period.

Waves

Wave motion: Transverse and longitudinal waves, speed of travelling wave, displacement relation for a progressive wave, principle of superposition of waves, reflection of waves, standing waves in strings and organ pipes, fundamental mode and harmonics, Beats.

Motion in a Straight Line

Frame of reference, Motion in a straight line, Elementary concepts of differentiation and integration for describing motion, uniform and non- uniform motion, and instantaneous velocity, uniformly accelerated motion, velocity - time and position-time graphs. Relations for uniformly accelerated motion (graphical treatment).

Motion in a Plane

Scalar and vector quantities; position and displacement vectors, general vectors and their notations; equality of vectors, multiplication of vectors by a real number; addition and subtraction of vectors, Unit vector; resolution of a vector in a plane, rectangular components, Scalar and Vector product of vectors. Motion in a plane, cases of uniform velocity and uniform acceleration-projectile motion, uniform circular motion.

Laws of Motion

Intuitive concept of force, Inertia, Newton's first law of motion; momentum and Newton's second law of motion; impulse; Newton's third law of motion. Law of conservation of linear momentum and its applications. Equilibrium of concurrent forces, Static and kinetic friction, laws of friction, rolling friction, lubrication. Dynamics of uniform circular motion: Centripetal force, examples of circular motion (vehicle on a level circular road, vehicle on a banked road).

Work, Energy and Power

Work done by a constant force and a variable force; kinetic energy, work- energy theorem, power. Notion of potential energy, potential energy of a spring, conservative forces: non- conservative forces, motion in a vertical circle; elastic and inelastic collisions in one and two dimensions.

System of Particles and Rotational Motion

Centre of mass of a two-particle system, momentum conservation and Centre of mass motion. Centre of mass of a rigid body; centre of mass of a uniform rod. Moment of a force, torque, angular momentum, law of conservation of angular momentum and its applications. Equilibrium of rigid bodies, rigid body rotation and equations of rotational motion, comparison of linear and rotational motions. Moment of inertia, radius of gyration, values of moments of inertia for simple geometrical objects (no derivation).

Gravitation

Kepler's laws of planetary motion, universal law of gravitation. Acceleration due to gravity and its variation with altitude and depth. Gravitational potential energy and gravitational potential, escape velocity, orbital velocity of a satellite.

Mechanical Properties of Solids

Elasticity, Stress-strain relationship, Hooke's law, Young’s modulus, bulk modulus, shear modulus of rigidity (qualitative idea only), Poisson's ratio; elastic energy.

Mechanical Properties of Fluids
Pressure due to a fluid column; Pascal's law and its applications (hydraulic lift and hydraulic brakes), effect of gravity on fluid pressure. Viscosity, Stokes' law, terminal velocity, streamline and turbulent flow, critical velocity, Bernoulli's theorem and its simple applications. Surface energy and surface tension, angle of contact, excess of pressure across a curved surface, application of surface tension ideas to drops, bubbles and capillary rise.

Thermal Properties of Matter
Heat, temperature, thermal expansion; thermal expansion of solids, liquids and gases, anomalous expansion of water; specific heat capacity; Cp, Cv - calorimetry; change of state - latent heat capacity. Heat transfer-conduction, convection and radiation, thermal conductivity, qualitative ideas of Blackbody radiation, Wein's displacement Law, Stefan's law.

Thermodynamics
Thermal equilibrium and definition of temperature zeroth law of thermodynamics, heat, work and internal energy. First law of thermodynamics, Second law of thermodynamics: gaseous state of matter, change of condition of gaseous state -isothermal, adiabatic, reversible, irreversible, and cyclic processes.

Kinetic Theory
Equation of state of a perfect gas, work done in compressing a gas. Kinetic theory of gases - assumptions, concept of pressure. Kinetic interpretation of temperature; rms speed of gas molecules; degrees of freedom, law of equipartition of energy (statement only) and application to specific heat capacities of gases; concept of mean free path, Avogadro's number.

CHEMISTRY

Some Basic Concepts of Chemistry: General Introduction: Importance and scope of Chemistry. Atomic and molecular masses, mole concept and molar mass, percentage composition, empirical and molecular formula, chemical reactions, stoichiometry and calculations based on stoichiometry.

Structure of Atom: Bohr's model and its limitations, concept of shells and subshells, dual nature of matter and light, de Broglie's relationship, Heisenberg uncertainty principle, concept of orbitals, quantum numbers, shapes of s, p and d orbitals, rules for filling electrons in orbitals - Aufbau principle, Pauli's exclusion principle and Hund's rule, electronic configuration of atoms, stability of half-filled and completely filled orbitals.

Classification of Elements and Periodicity in Properties: Modern periodic law and the present form of periodic table, periodic trends in properties of elements - atomic radii, ionic radii, inert gas radii, Ionization enthalpy, electron gain enthalpy, electronegativity, valency. Nomenclature of elements with atomic number greater than 100.

Chemical Bonding and Molecular Structure: Valence electrons, ionic bond, covalent bond, bond parameters, Lewis structure, polar character of covalent bond, covalent character of ionic bond, valence bond theory, resonance, geometry of covalent molecules, VSEPR theory, concept of hybridization involving s, p and d orbitals and shapes of some simple molecules, molecular orbital theory of homonuclear diatomic molecules (qualitative idea only), Hydrogen bond.

Redox Reactions: Concept of oxidation and reduction, redox reactions, oxidation number, balancing redox reactions - in terms of loss and gain of electrons and change in oxidation number.

Hydrogen: Position of hydrogen in periodic table, occurrence, isotopes, hydrides, ionic, covalent and interstitial; physical and chemical properties of water, heavy water, hydrogen as a fuel.

Organic Chemistry: Some basic Principles and Techniques: General introduction, classification and IUPAC nomenclature of organic compounds. Electronic displacements in a covalent bond: inductive effect, electromeric effect, resonance and hyper conjugation. Homolytic and heterolytic fission of a covalent bond: free radicals, carbocations, carbanions, electrophiles and nucleophiles, types of organic reactions.

States of Matter: Gases and Liquids: Three states of matter, intermolecular interactions, types of bonding, melting and boiling points, role of gas laws in elucidating the concept of the molecule, Boyle's law, Charles law, Gay Lussac's law, Avogadro's law, ideal behaviour, empirical derivation of gas equation, Avogadro's number, ideal gas equation and deviation from ideal behaviour.

Chemical Thermodynamics: Concepts of System and types of systems, surroundings, work, heat, energy, extensive and intensive properties, state functions. First law of thermodynamics - internal energy and enthalpy, measurement of ΔU and ΔH, Hess's law of constant heat summation, enthalpy of bond dissociation, combustion, formation, atomization, sublimation, phase transition, ionization, solution and dilution. Second law of Thermodynamics (brief introduction) Introduction of entropy as a state function, Gibb's energy change for spontaneous and non- spontaneous processes. Third law of thermodynamics (brief introduction).

Equilibrium: Equilibrium in physical and chemical processes, dynamic nature of equilibrium, law of mass action, equilibrium constant, factors affecting equilibrium - Le Chatelier's principle, ionic equilibrium- ionization of acids and bases, strong and weak electrolytes, degree of ionization, ionization of poly basic acids, acid strength, concept of pH, buffer solution, solubility product, common ion effect (with illustrative examples).

s-Block Elements: Group 1 and Group 2 Elements -General introduction, electronic configuration, occurrence, anomalous properties of the first element of each group, diagonal relationship, trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii), trends in chemical reactivity with oxygen, water, hydrogen and halogens, uses.

Some p-Block Elements: General Introduction to p -Block Elements Group 13 Elements: General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous properties of first element of the group, Boron - physical and chemical properties. Group 14 Elements: General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous behaviour of first elements. Carbon - catenation, allotropic forms, physical and chemical properties.

Hydrocarbons: Classification of Hydrocarbons Aliphatic Hydrocarbons: Alkanes - Nomenclature, isomerism, conformation (ethane only), physical properties, chemical reactions. Alkenes - Nomenclature, structure of double bond (Ethene), geometrical isomerism, physical properties, methods of preparation, chemical reactions:- addition of Hydrogen, Halogen, water, hydrogen halides (Markovnikov's addition and peroxide effect), Ozonolysis, Oxidation, mechanism of electrophilic addition. Alkynes - Nomenclature, structure of triple bond (Ethyne), physical properties, methods of preparation, chemical reactions: acidic character of alkynes, addition reaction of - hydrogen, halogens, hydrogen halides and water.

Aromatic Hydrocarbons: Introduction, IUPAC nomenclature, benzene: resonance, aromaticity, chemical properties: mechanism of electrophilic substitution. Nitration, sulphonation,

halogenation, Friedel Craft's alkylation and acylation, directive influence of functional group in monosubstituted benzene. Carcinogenicity and toxicity.

Solid State: Classification of solids based on different binding forces: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea). Unit cell in two dimensional and three-dimensional lattices, calculation of density of unit cell, packing in solids, packing efficiency, voids, number of atoms per unit cell in a cubic unit cell, point defects.

Solutions: Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, Raoult's law, colligative properties- relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties.

p-Block Elements: Group-15 Elements: General introduction, electronic configuration, occurrence, oxidation states, trends in physical and chemical properties; Nitrogen preparation properties and uses; compounds of Nitrogen: preparation and properties of Ammonia and Nitric Acid. Group 16 Elements: General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties, dioxygen: preparation, properties and uses, classification of Oxides, Ozone, Sulphur -allotropic forms; compounds of Sulphur: preparation properties and uses of Sulphur-dioxide, Sulphuric Acid: properties and uses; Oxoacids of Sulphur (Structures only). Group 17 Elements: General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties; compounds of halogens, Preparation, properties and uses of Chlorine and Hydrochloric acid, interhalogen compounds, Oxoacids of halogens (structures only). Group 18 Elements: General introduction, electronic configuration, occurrence, trends in physical and chemical properties, uses.

Haloalkanes and Haloarenes: Haloalkanes: Nomenclature, nature of C–X bond, physical and chemical properties, optical rotation mechanism of substitution reactions. Haloarenes: Nature of C–X bond, substitution reactions (Directive influence of halogen in monosubstituted compounds only).

Alcohols, Phenols and Ethers: Alcohols: Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only), identification of primary, secondary and tertiary alcohols, mechanism of dehydration. Phenols: Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophillic substitution reactions, uses of phenols. Ethers: Nomenclature, methods of preparation, physical and chemical properties, uses.

Biomolecules: Carbohydrates - Classification (aldoses and ketoses), monosaccahrides (glucose and fructose), D-L configuration Proteins -Elementary idea of - amino acids, peptide bond, polypeptides, proteins, structure of proteins - primary, secondary, tertiary structure and quaternary structures (qualitative idea only), denaturation of proteins. Nucleic Acids: DNA and RNA.

MATHEMATICS

Sets: Empty set, Finite and Infinite sets, Equal sets, Subsets, Power set, Universal set, Venn diagrams. Union and Intersection of sets. Difference of sets. Complement of a set. Properties of Complement. Ordered pairs. Cartesian product of sets. Number of elements in the Cartesian product of two finite sets.

Relations & Functions: Definition of relation, domain, co-domain and range of a relation. Types of relations: reflexive, symmetric, transitive and equivalence relations. Function as a special type of relation. Domain, co-domain and range of a function. Types of functions. Sum, difference, product and quotients of functions.

Trigonometric Functions: Measuring angles in radians and in degrees and conversion from one

measure to another. Definition of trigonometric functions with the help of unit circle. Domain and range of trigonometric functions and their graphs. Trigonometric identities. General solution of trigonometric equations. Definition and elementary properties of inverse trigonometric functions.

Algebra: Principle of mathematical induction and simple applications. Permutations and Combinations with simple applications. Binomial theorem. Pascal's triangle, General and middle term in binomial expansion, simple applications.

Complex Numbers and Quadratic Equations: Algebraic properties of complex numbers. Argand plane and polar representation of complex numbers. Statement of Fundamental Theorem of Algebra. Solutions of quadratic equations (with real coefficients) in the complex number system. Square root of a complex number.

Matrices: Concept, notation, order, equality, types of matrices. Operations on matrices. Concept of elementary row and column operations. Invertible matrices (Here all matrices will have real entries). **Determinants-** Determinant of a square matrix and properties of determinants. Adjoint and inverse of a square matrix. Consistency, inconsistency and number of solutions of system of linear equations by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix.

Linear Inequalities-: Solutions of linear inequalities in one variable as well as in two variables.

Sequence and Series: Definitions of sequence and series. Arithmetic Progression (A. P.). Arithmetic Mean (A.M.). Geometric Progression (G.P.). Geometric Mean (G.M.). Simple applications regarding A.P.and G.P.

Coordinate Geometry:

Straight Lines- Various forms of equations of a line, slope of a line and angle between two lines. Distance of a point from a line.

Conic Sections- Circle, 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 circle, parabola, ellipse and hyperbola. **Introduction to Three-dimensional Geometry--** Coordinate axes and coordinate planes in three dimensions. Coordinates of a point. Distance between two points and section formula.

Calculus:

Limit, Continuity and Derivative-- Concept of limit of a function, Definitions of Continuity and differentiability of a function. Algebra of limits of functions, continuous functions and derivatives of functions. Chain rule. Rolle's and Lagrange's Mean Value Theorems (without proof) and their geometric interpretation. Applications of limits, continuity and derivatives. **Integrals--** Integration as inverse process of differentiation. Integration of a variety of functions Definite integrals as a limit of a sum, Fundamental Theorem of Calculus (without proof). Basic properties of definite integrals and evaluation of definite integrals. **Applications of the Integrals--** Applications in finding the area under simple curves, especially lines, circles/ parabolas/ellipses (in standard form only), Area between any of the two above said curves (the region should be clearly identifiable).

Differential Equations: Definition, order and degree, general and particular solutions of a differential equation. Formation of differential equation whose general solution is given. Solution of differential equations by method of separation of variables, solutions of homogeneous differential equations of firstorder and first degree.

Vectors and Three-Dimensional Geometry:

Vectors and Scalars-- Definition of a vector and also of a scalar. Direction cosines and direction ratios of a vector. Types of 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. Properties and applications of scalar (dot) product of vectors, vector (cross) product of vectors, and scalar triple product of vectors.

Three-dimensional Geometry-- Direction cosines and direction ratios of a line joining two points. Cartesian equation 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.

Linear Programming: Introduction, related terminology such as constraints, objective 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 (bounded or unbounded), feasible and infeasible solutions, optimal feasible solutions (up to three non- trivial constraints).

Statistics and Probability:

Statistics--Measures of Dispersion: Range, 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; occurrenceof events, 'not', 'and' and 'or' events, exhaustive events, mutually exclusive events, Axiomatic (set theoretic) probability, connections with other theories of earlier classes. Probability of an event, probability of 'not', 'and' and 'or' events. Conditional probability, multiplication theorem on probability, independent events, total probability, Bayes' theorem. Random variable and its probability distribution, mean and variance of random variable. Binomial probability distribution.

For Admission to: B. Sc. (Hons.) Biotechnology, B.Sc. (Hons.) Environmental Science, B.Sc. (BZCEM – Bio group).

Question Paper Pattern (All Parts are Compulsory)	**Time: 02 Hours**	**Zoology**	**Botany**	**Bio-Technology**	**Microbiology**	**Chemistry**
	Total: 100 MCQs	**30**	**30**	**10**	**10**	**20**

Syllabus: Zoology, Botany, Chemistry 10+2 level CBSE/ICSE/UP Board

Classification and Taxonomy

Plant Kingdom Classification-Algae, Bryophyta, Pteridophyta, Gymnosperm, Angiosperms. Plants Morphology of Flowering Plants, Elementary idea about angiospermics taxonomy. Biodiversity and its Conservation. Aimal Kingdom: Chordates and non-chordates.

Molecular Cell Biology and Genetics

Structure of prokaryotic and eukaryotic cells; cell membrane, cell organelles and their functions, Cell Division, Mendelian and Non-Mendelian genetics, Sex determination, linkage and crossing over; sex linked inheritance-haemophilia, colour blindness; various types of syndromes. Structure of DNA and RNA, DNA replication, transcription and translation.

Biochemistry and Physiology

Carbohydrates, proteins, lipids, nucleic acids and their metabolism; Photosynthesis; Animal Physiology- digestive, Respiratory, Circulatory, Excretory, Nervous and Reproductive system, Endocrinology and associated disorders.

Biotechnology, Microbiology and Environment

Biotechnology basic principles, Application of biotechnology, Elementary idea about

microbiology and their application, Ecology, Environment and Ecosystem.

Master of Science (M. Sc.)

For Admission to: M. Sc. Biotechnology/M. Sc. Microbiology/M. Sc. Biochemistry /M. Sc. Food Science and Technology

Question Paper Pattern (All Parts are Compulsory)	Time: 02 Hours	Zoology	Botany	Bio-Technology	Microbiology	Food and Science Technology
	Total: 100 MCQs	25	25	20	20	10

For Admission to: M. Sc. Environmental Science :

Question Paper Pattern (All Parts are Compulsory)	Time: 02 Hours	Zoology	Botany	Bio-Technology	Microbiology	Environment Science	Chemistry
	Total: 100 MCQs	25	25	05	05	25	15

Syllabus:

ZOOLOGY

Diversity of Non-Chordates, Parasitology and economic zoology; Diversity of chordates and Comparative anatomy; Animal physiology; Endocrinology, Evolutionary and developmental biology, Animal behaviour; Ethology, Wildlife.

BOTANY

Nomenclature and classification of plants; Elementary idea about bacteria, fungi, virus, bryophytes, pteridophytes, gymnospers and angiosperms; Embryology; Types of plant reproduction; Mendel's Law of inheritance; Linkage and recombination; plant pathology.

CELL BIOLOGY & MOLECULAR BIOLOGY

Structure of prokaryotic and eukaryotic cell, cell organelles, membrane structure and function, cytoskeleton, cell cycle, nucleic acids properties and functions, replication, Transcription, Translation; Genetic code. Elementary idea about Recombinant DNA technology and its applications. PCR. Elementary idea about immunology.

BIOCHEMISTRY

Macromolecules: carbohydrates, lipids, proteins, nucleic acids and their metabolism; Enzymes; Vitamins; mole concept, pH; Buffers; Water as a solvent;

MICROBIOLOGY

General properties and principles of classification of actinomycetes, bacteria, fungi and viruses and their genetics; prokaryotic genome organization; plasmid and vector; Microbial interactions; Biogeochemical cycle- Nitrogen, Sulphur, Carbon and Phosphorus; Sterilization techniques. Microscopy.

FOOD SCIENCE AND TECHNOLOGY

Nutrient and Nutrition, Elementary idea about Carbohydrates, Lipids, Proteins, Nucleic Acid ; Vitamins; Minerals; Diseases due to nutrient deficiencies; Microbial food Spoilage, Food preservation.

ENVIRONMENTAL SCIENCE

Components of Environment; Ecological Pyramid; Ecological Factors; Environmental pollution-Types, sources, impact and their control measures; Bioremediation; Environmental protection laws.

Master of Business Administration (MBA)

For Admission to: MBA, MBA (Business Economics), MBA (Finance & Control), MBA (e-Commerce), MBA (Agri-Business), MBA (HRD).

Question Paper Pattern (All Parts are Compulsory)	Time: 02 Hours	Sec. A	Sec. B	Sec. C	Sec. D
	Total: 100 MCQs	25	25	25	25

Syllabus

Section A

English Language-Grammar Vocabulary Uncommon words Sentence completion Synonyms Antonyms Relationship between words & phrases Comprehension of passages

Section B

Numerical Aptitude-Numerical calculation Arithmetic Simple algebra Geometry and trigonometry Interpretation of graphs Charts and tables.

Section C

Thinking and Decision-Making Creative thinking unfamiliar relationships Verbal reasoning finding patterns trends Assessment of figures & diagrams

Section D

General Awareness-Knowledge of current affairs other issues related to trade, industry, economy, sports, culture and science.

D. Pharm

Question Paper Pattern (All questions of Physics and Chemistry are compulsory and candidates should solve either of Biology or Mathematics questions)	Time: 02 Hours	Physics	Chemistry	Mathematics/Biology
	Total: 100 MCQs	35	35	30

Syllabus

Physics:-Units and measurements, motion in a straight line, motion in a plane, lows of motion, work, energy and power, system of particles and rotational motion, gravitation, mechanical properties of solids, thermal properties of fluids, thermodynamics, kinetic theory, oscillations, waves, electric charges and fields, electrostatic potential and capacitance, current electricity, moving charges and magnetism, magnetism and matter, electromagnetic induction, alternating current, electromagnetic waves, ray optics, dual nature of radiation, atoms, nuclei, semiconductor electronics: materials, devices and simple circuits.

Chemistry:-Basic concepts of chemistry, structure of atoms, classification of elements and periodicity in properties, chemical bonding and molecular structure, states of matter, thermodynamics, equilibrium, redox reactions, s-block elements, p-block elements, d and f- block elements, hydrocarbons, environmental chemistry, the solid state, solutions, electrochemistry, chemical kinetics, surface chemistry, general principles and processes of isolation of elements, coordination compounds, haloalkanes, alcohols, phenols and ethers, aldehydes, ketones, and carboxylic acids, amines, biomolecules, polymers, chemistry in everyday life.

Biology:-The living world, biological classification, plant kingdom, animal kingdom, morphology of flowering plants, anatomy of flowering plants, structural organisation in animals, Cell, biomolecules, cell cycle and cell division, transport in plants, mineral nutrition, photosynthesis, respiration, plant growth and development, digestion and absorption, breathing and exchange of gases, body fluids and circulation, excretory products and their elimination, locomotion and movement, neural control and coordination, chemical coordination and integration, reproduction in organism, sexual reproduction in flowering plants, principles of inheritance and variation, molecular basis of inheritance, evolution, human health and diseases, microbes in human welfare, biotechnology and its application, organisms and populations, ecosystems, biodiversity and conservation, environmental issues.

Mathematics:- Relations and functions, inverse trigonometric functions, matrices, determinants, continuity and differentiability, application of derivatives, integrals, application of integrals, differential equation, vector algebra, three dimensional geometry, linear programming, probability, sets, complex numbers and quadratic equations, linear inequalities, permutations and combinations, binomial theorem, sequence and series, conic sections, limits and derivatives, statistics, mathematical reasoning.

Bachelor of Computer Applications (BCA)

Question Paper Pattern (All Parts are Compulsory)	Time: 02 Hours	Sec. A	Sec. B	Sec. C	Sec. D	Sec. E
	Total: 100 MCQs	20	20	20	20	20

Syllabus:

Comprises of five sections: Arithmetic Aptitude, Logical reasoning, Computer Awareness, English language and General Knowledge & Current Affairs.

Section-A: Arithmetic Aptitude- Percentage, Profit and Loss, Calendar problem, Simplification, Average, Problem on Trains, Time and work, Probability, Simple & compound Interest, Problems on Ages, Clock, Volume and Surface Area, Ratio.

Section-B: Reasoning- Odd man out, Analogy, Letter and Symbol Series, Letter and Symbol Series, Blood Relation, Logical Problems, Statement and Conclusion, Artificial Language, Data Sufficiency.

Section-C: Computer Awareness – Introduction, Generation of computers, Operating system, History of Computer, Input/output devices, Hardware & Software, Computer networks, Data Processing, Computer Memory.

Section-D: General English- One Word Substitution, Synonyms, Antonyms, Grammar, Idioms

and Phrases, Ordering of Words, Ordering of Sentences, Sentence Completion, Punctuation, Article.

Section-E: General Knowledge & Current Affairs- Knowledge of Current Affairs and other issues related to Trade, Industry, Economy, Govt. Program, National /International days, Sports, Culture and Science, Awards and Honours, Famous Personalities, World Rankings, Annul Reports of International Organizations/Institutions, Geography, History, Awards and Honours, Inventions.

Master of Computer Applications (MCA))/Integrated MCA

Question Paper Pattern (All Parts are Compulsory)	Time: 02 Hours	Thinking and Decision Making	Mathematics	Computer Awareness
	Total: 100 MCQs	**35**	**35**	**30**

Syllabus

Thinking and Decision Making

Creative thinking, unfamiliar relationships, verbal reasoning, finding patterns trends and Assessment of figures & diagrams. Geometrical designs &Identification, Selection of related letters / words / numbers /figures; Identification of odd thing / item out from a group; Completion of numerical series based on the pattern /logic. Fill in the blanks of the series based on the numerical pattern and logic of the series. Syllogisms (logic-based questions), Identification of logic & selection of correct answers based on the logic.

Mathematics

Set Theory: Concept of sets –Union, Intersection, Cardinality, Elementary counting; permutations and combinations. • Probability and Statistics: Basic concepts of probability theory, Averages, Dependent and independent events, frequency distributions, measures of central tendencies and dispersions.

Algebra: Fundamental operations in algebra, expansions, factorization, simultaneous linear /quadratic equations, indices, logarithms, arithmetic, geometric and harmonic progressions, determinants and matrices.

Coordinate Geometry: Rectangular Cartesian coordinates, distance formulae, equation of a line, and intersection of lines, pair of straight lines, equations of a circle, parabola, ellipse and hyperbola.

Calculus: Limit of functions, continuous function, differentiation of function, tangents and normal, simple examples of maxima and minima. Integration of functions by parts, by substitution and by partial fraction, definite integrals, applications of definite integrals to areas.

Vectors: Position vector, addition and subtraction of vectors, scalar and vector products and their applications to simple geometrical problems and mechanics.

Trigonometry: Simple identities, trigonometric equations, properties of triangles, solution of triangles, heights and distances, general solutions of trigonometric equations.

Computer Awareness

Computer Basics: Organization of a computer, Central Processing Unit (CPU), structure of instructions in CPU, input/output devices, computer memory, and back-up devices.

Data Representation: Representation of characters, integers and fractions, binary and hexadecimal representations, binary arithmetic: addition, subtraction, multiplication, division, simple arithmetic and two's complement arithmetic, floating point representation of numbers, Boolean algebra, truth tables, Venn diagrams.

Bachelor of Commerce [B. Com (Hons.)]

Question paper consists of 100 MCQs. All questions are Compulsory. Time: 2 Hr.

Syllabus: Basic Mathematics, Business Organization, Business Management, Accountancy, Financial Statement Analysis, Financial Markets, Economics, Money and Banking, Business

Environment, General English Computer Basics Current Economic Affairs and Reasoning.

Syllabus for B.A. LLB (Hons.)

Question Paper Pattern (All Parts are Compulsory)	Time: 02 Hours	Sec. A (Language Comprehension)		Sec. B (Aptitude)		Sec. C (General Awareness and Current Affairs)
	Total: 100 MCQs	English	Hindi	Reasoning, Mental Ability	Legal Aptitude	
		20	10	20	20	30

LLM

Question paper consists of 100 MCQs. All questions are Compulsory. Time: 2 Hr.

Syllabus:

1. Constitutional Law; 2. Jurisprudence; 3. Law of Contract; 4. Criminal Law (BNS); 5. Administrative Law; 6. Family Law; 7. Law of Torts; 8. Environmental Law; 9. IT Law; 10. Human Rights; 11. Public International Law.

Bachelor of Business Administration (BBA)

Question Paper Pattern (All Parts are Compulsory)	Time: 02 Hours	Sec. A	Sec. B	Sec. C	Sec. D
	Total: 100 MCQs	25	25	25	25

Syllabus

Section-A: English Language-Comprehension of Passage, Verbal Reasoning, Sentence completion, Fill in the Blanks, One word substitution, Syllogisms, Sentence correction, Idioms, Analogies, Different usage of same word.

Section-B: Numerical and Data Analysis-Geometry, Work and time, Number system, Percentages, HCF & LCM, Averages, Profit & Loss, Ratios and Proportion, Arithmetic Progression, Time-Speed-Distance.

Section-C: Reasoning and Intelligence-Coding & Decoding, Visual reasoning, Pie Chart, Puzzles, Arrangement, Series, Family tree, Blood Relations, Calendars, Statement Conclusions, Syllogisms.

Section-D: General Knowledge-Government and Politics, Famous Personalities, Business, Economy, History, Static GK, Geography, Current affairs.

Bachelor of Technology (B.Tech.)

For Admission to: B. Tech. in Computer Science & Engineering (CSE), AI & ML, Data Science, IoT, Information Technology (IT), Electronics & Communication Engineering (ECE), Electronics Engineering (ECE), Electrical Engineering (EE) and Renewable Engineering, Electrical and Computer Engineering (EE), Mechanical Engineering (ME) and Polytechnic/Diploma in Mechanical Engineering (Production) Lateral Entry in 2nd Year,

Question Paper Pattern (All Parts are Compulsory)	Time: 02 Hours	Physics	Chemistry	Mathematics
	Total: 100 MCQs	**30**	**30**	**40**

Syllabus

MATHEMATICS

UNIT 1: SETS, RELATIONS, AND FUNCTIONS: Sets and their representation: Union, intersection, and complement of sets and their algebraic properties; Power set; Relation, Type of relations, equivalence relations, functions; one-one, into and onto functions, the composition of functions.

UNIT 2: COMPLEX NUMBERS AND QUADRATIC EQUATIONS: Complex numbers as ordered pairs of reals, Representation of complex numbers in the form a + ib and their representation in a plane, Argand diagram, algebra of complex number, modulus,and argument (or amplitude) of a complex number, Quadratic equations in real and complex number system and their solutions Relations between roots and co-efficient, nature of roots, the formation of quadratic equations with given roots.

UNIT3: MATRICES AND DETERMINANTS: Matrices, algebra of matrices, type of matrices, determinants, and matrices of order two and three, evaluation of determinants, area of triangles using determinants, Adjoint, and evaluationof inverse of a square matrix using determinants and, Test of consistency and solution of simultaneous linear equations in two or three variables using matrices.

UNIT 4: PERMUTATIONS AND COMBINATIONS: The fundamental principle of counting, permutation as an arrangement and combination as section, Meaning of P (n,r) and C (n,r), simple applications.

UNIT 5: BINOMIAL THEOREM AND ITS SIMPLE APPLICATIONS: Binomial theorem for a positive integral index, general term and middle term, and simple applications.

UNIT 6: SEQUENCE AND SERIES: Arithmetic and Geometric progressions, insertion of arithmetic, geometric means between twogiven numbers, Relation between A.M and G.M.

UNIT 7: LIMIT, CONTINUITY, AND DIFFERENTIABILITY: Real–valued functions, algebra of functions, polynomials, rational, trigonometric, logarithmic,and exponential functions, inverse function. Graphs of simple functions. Limits, continuity, and differentiability. Differentiation of the sum, difference, product, and quotient of two functions. Differentiation of trigonometric, inverse trigonometric, logarithmic, exponential, composite, and implicit functions; derivatives of order up to two, Applications of derivatives: Rate of change of quantities, monotonic-Increasing and decreasing functions, Maxima and minima of functions of one variable.

UNIT 8: INTEGRAL CALCULAS: Integral as anti-derivative, Fundamental integral involving algebraic, trigonometric, exponential, and logarithmic functions. Integrations by substitution, by parts, and by partial functions. Integration using trigonometric identities. Evaluation of simple integrals. The fundamental theorem of calculus, properties of definite integrals. Evaluation of definite integrals, determining areas of the regions bounded by simple curves in standard form.

UNIT 9: DIFFRENTIAL EQUATIONS: Ordinary differential equations, their order, and degree, the solution of differential equation bythe method of separation of variables, solution of a homogeneous and linear differential equation.

UNIT 10: CO-ORDINATE GEOMETRY: Cartesian system of rectangular coordinates in a plane, distance formula, sections formula, locus, and its equation, the slope of a line, parallel and perpendicular lines, intercepts of a lineon the co-ordinate axis.

Straight line: Various forms of equations of a line, intersection of lines, angles between two lines, conditions for concurrence of three lines, the distance of a point form a line, co-ordinate of the centroid, ortho-centre, and circum-centre of a triangle.

Circle, conic sections

A standard form of equations of a circle, the general form of the equation of a circle, its radius and central, equation of a circle when the endpoints of a diameter are given, points of intersection of a line and a circle with the centre at the origin and sections of conics, equations of conic sections (parabola, ellipse, and hyperbola) in standard forms.

UNIT 11: THREE-DIMENSIONAL GEOMETRY: Coordinates of a point in space, the distance between two points, section formula, directions ratios, and direction cosines, and the angle between two intersecting lines. Skew lines, the shortest distance between them, and its equation. Equations of a line

UNIT 12: VECTOR ALGEBRA: Vectors and scalars, the addition of vectors, components of a vector in two dimensions and three-dimensional space, scalar and vector products.

UNIT 13: STATISTICS AND PROBABILITY: Measures of discretion; calculation of mean, median, mode of grouped and ungrouped data calculation of standard deviation, variance, and mean deviation for grouped and ungrouped data. Probability: Probability of an event, addition and multiplication theorems of probability, Baye'stheorem, probability distribution of a random variate.

UNIT 14: TRIGONOMETRY: Trigonometrical identities and trigonometrical functions, inverse trigonometrical functions, and their properties.

PHYSICS

UNIT 1: PHYSICS AND MEASUREMENT: Units of measurements, System of Units, S I Units, fundamental and derived units, least count, significant figures, Errors in measurements, Dimensions of Physics quantities, dimensional analysis, and its applications.

UNIT 2: KINEMATICS: The frame of reference, motion in a straight line, Position- time graph, speed and velocity; Uniform and non-uniform motion, average speed and instantaneous velocity, uniformly accelerated motion, velocity-time, position-time graph, relations for uniformly accelerated motion, Scalars and Vectors, Vector. Addition and subtraction, scalar and vector products, Unit Vector, Resolution of a Vector. Relative Velocity, Motion in a plane, Projectile Motion, Uniform Circular Motion.

UNIT 3: LAWS OF MOTION: Force and inertia, Newton's First law of motion; Momentum, Newton's Second Law of motion, Impulses; Newton's Third Law of motion. Law of conservation of linear momentum and its applications. Equilibrium of concurrent forces. Static and Kinetic friction, laws of friction, rolling friction. Dynamics of uniform circular motion: centripetal force and its applications: vehicle on a levelcircular road, vehicle on a banked road.

UNIT 4: WORK, ENERGY, AND POWER: Work done by a constant force and a variable force; kinetic and potential energies, work-energy theorem, power. The potential energy of spring conservation of mechanical energy, conservative and non- conservative forces; motion in a vertical circle: Elastic and inelastic collisions in one and twodimensions.

UNIT5: ROTATIONAL MOTION: Centre of the mass of a two-particle system, Centre of the mass of a rigid body; Basic concepts of rotational motion; moment of a force; torque, angular momentum, conservation of angular momentum and its applications; The moment of inertia, the radius of gyration, values of moments of inertia for simple geometrical objects, parallel and perpendicular axes theorems, and their applications. Equilibrium of rigid bodies, rigid body rotation and equations of rotational motion, comparisonof linear and rotational motions.

UNIT 6: GRAVITATION: The universal law of gravitation. Acceleration due to gravity and its variation with altitude anddepth. Kepler's law of planetary motion. Gravitational potential energy; gravitational potential. Escape velocity, Motion of a satellite, orbital velocity, time period, and energy of satellite.

UNIT 7: PROPERTIES OF SOLIDS AND LIQUIDS: Elastic behavior, Stress-strain relationship, Hooke's Law. Young's modulus, bulk modulus, and modulus of rigidity. Pressure due to a fluid column; Pascal's law and its applications. Effectof gravity on fluid pressure. Viscosity. Stokes' law. terminal velocity, streamline, and turbulent flow. Critical velocity. Bernoulli's principle and its applications. Surface energy and surface tension, angle of contact, excess of pressure across a curved surface,application of surface tension - drops, bubbles, and capillary rise. Heat, temperature, thermal expansion; specific heat capacity, calorimetry; change of state, latent heat. Heat transfer- conduction, convection, and radiation.

UNIT 8: THERMODYNAMICS: Thermal equilibrium, zeroth law of thermodynamics, the concept of temperature. Heat, work, and internal energy. The first law of thermodynamics, isothermal and adiabatic processes. The second law of thermodynamics: reversible and irreversible processes.

UNIT 9: KINETIC THEORY OF GASES: Equation of state of a perfect gas, work done on compressing a gas, Kinetic theory of gases - assumptions, the concept of pressure. Kinetic interpretation of temperature: RMS speed of gas molecules: Degrees of freedom. Law of equipartition of energy and applications to specific heat capacities of gases; Mean free path. Avogadro's number.

UNIT 10: OSCILLATIONS AND WAVES: Oscillations and periodic motion–time period, frequency, displacement as a function of time. Periodic functions. Simple harmonic motion (S.H.M.) and its equation; phase: oscillations of a spring -restoring force and force constant: energy in S.H.M. - Kinetic and potential energies; Simple pendulum - derivation of expression for its time period. Wave motion. Longitudinal and transverse waves, speed of the travelling wave. Displacement relation for a progressive wave. Principle of superposition of waves, reflection of waves. Standing waves in strings and organ pipes, fundamental mode, and harmonics. Beats.

UNIT 11: ELECTROSTATICS: Electric charges: Conservation of charge. Coulomb's law forces between two-point charges, forces between multiple charges: superposition principle and continuous charge distribution. Electric field: Electric field due to a point charge, Electric field lines. Electric dipole, Electric field due to a dipole. Torque on a dipole in a uniform electric field. Electric flux. Gauss's law and its applications to find field due to infinitely long uniformly charged straight wire uniformly charged infinite plane sheet, and uniformly charged thin spherical shell. Electric potential and its calculation for a point charge, electric dipole and system of charges; potential difference, Equipotential surfaces, Electrical potential energy of a system of two-point charges and of electric dipole in an electrostatic field. Conductors and insulators. Dielectrics and electric polarization, capacitors and capacitances, the combination of capacitors in series and parallel, and capacitance of a parallel plate capacitorwith and without dielectric medium between the plates. Energy stored in a capacitor.

UNIT 12: CURRENT ELECTRICITY: Electric current. Drift velocity, mobility, and their relation with electric current. Ohm's law. Electrical resistance. V-l characteristics of Ohmic and non-ohmic conductors. Electrical energyand power. Electrical resistivity and conductivity. Series and parallel combinations of resistors;Temperature dependence of resistance. Internal resistance, potential difference, and emf of a cell, a combination of cells in series and parallel. Kirchhoff's laws and their applications. Wheatstone bridge. Metre Bridge.

UNIT 13: MAGNETIC EFFECTS OF CURRENT AND MAGNETISM: Biot - Savart law

and its application to the current carrying circular loop. Ampere's law and its applications to infinitely long current carrying straight wire and solenoid. Force on a moving charge in uniform magnetic and electric fields. Force on a current-carrying conductor in a uniform magnetic field. The force between two parallel currents carrying conductors-definition of ampere. Torque experienced by a current loop in a uniform magnetic field: Moving coil galvanometer, its sensitivity, and conversion to ammeter and voltmeter. Current loop as a magnetic dipole and its magnetic dipole moment. Bar magnet as an equivalent solenoid, magnetic field lines; Magnetic field due to a magnetic dipole (bar magnet) along itsaxis and perpendicular to its axis. Torque on a magnetic dipole in a uniform magnetic field. Para-, dia- and ferromagnetic substances with examples, the effect of temperature on magneticproperties.

UNIT 14: ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS: Electromagnetic induction: Faraday's law. Induced emf and current: Lenz's Law, Eddy currents. Self and mutual inductance. Alternating currents, peak and RMS value of alternating current/ voltage: reactance and impedance: LCR series circuit, resonance: power in AC circuits, wattless current. AC generator and transformer.

UNIT 15: ELECTROMAGNETIC WAVES: Displacement current. Electromagnetic waves and their characteristics, Transverse nature of electromagnetic waves, Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet. X-rays. Gamma rays), Applications of e.m. waves.

UNIT 16: OPTICS: Reflection of light, spherical mirrors, mirror formula. Refraction of light at plane and spherical surfaces, thin lens formula, and lens maker formula. Total internal reflection and its applications. Magnification. Power of a Lens. Combination of thin lenses in contact. Refraction of light through a prism. Microscope and Astronomical Telescope (reflecting and refracting) and their magnifying powers. Wave optics: wavefront and Huygens' principle. Laws of reflection and refraction using Huygens principle. Interference, Young's double-slit experiment, and expression for fringe width, coherent sources, and sustained interference of light. Diffraction due to a single slit, width of central maximum. Polarization, plane-polarized light: Brewster's law, uses of plane- polarized light and Polaroid.

UNIT 17: DUAL NATURE OF MATTER AND RADIATION: Dual nature of radiation. Photoelectric effect. Hertz and Lenard's observations; Einstein's photoelectric equation: particle nature of light. Matter waves-wave nature of particle, de Broglie relation.

UNIT 18: ATOMS AND NUCLEI: Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum. Composition and size of nucleus, atomic masses, Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number, nuclear fission, and fusion.

UNIT 19: ELECTRONIC DEVICES: Semiconductors; semiconductor diode: I-V characteristics in forward and reverse bias; diode as a rectifier; I-V characteristics of LED. the photodiode, solar cell, and Zener diode; Zener diode as a voltage regulator. Logic gates (OR. AND. NOT. NAND and NOR).

UNIT 20: EXPERIMENTAL SKILLS: Familiarity with the basic approach and observations of the experiments and activities:

1. Vernier calipers -its use to measure the internal and external diameter and depth of a vessel.
2. Screw gauge-its use to determine the thickness/ diameter of thin sheet/wire.
3. Simple Pendulum-dissipation of energy by plotting a graph between the square of amplitude and time.
4.Metre Scale - the mass of a given object by the principle of moments.

5.Young's modulus of elasticity of the material of a metallic wire.
6.Surf ace tension of water by capillary rise and effect of detergents,
7. Co-efficient of Viscosity of a given viscous liquid by measuring the terminal velocity of a given spherical body,
8. Speed of sound in air at room temperature using a resonance tube,
9. Specific heat capacity of a given (i) solid and (ii) liquid by method of mixtures.
10. The resistivity of the material of a given wire using a metre bridge.
11. The resistance of a given wire using Ohm's law.
12. Resistance and figure of merit of a galvanometer by half deflection method.
13. The focal length of: (i) Convex mirror; (ii) Concave mirror, and (iii) Convex lens, using the parallax method.
14. The plot of the angle of deviation vs angle of incidence for a triangular prism.
15. The refractive index of a glass slab using a travelling microscope.
16. Characteristic curves of a p-n junction diode in forward and reverse bias.
17. Characteristic curves of a Zener diode and finding reverse breakdown voltage.
18. Identification of Diode. LED, Resistor. A capacitor from a mixed collection of such items.

CHEMISTRY

PHYSICAL CHEMISTRY

UNIT I: SOME BASIC CONCEPTS IN CHEMISTRY: Matter and its nature, Dalton's atomic theory: Concept of atom, molecule, element, and compound: Laws of chemical combination; Atomic and molecular masses, mole concept, molar mass, percentage composition, empirical and molecular formulae: Chemical equations and stoichiometry.

UNIT 2: ATOMIC STRUCTURE: Nature of electromagnetic radiation, photoelectric effect; Spectrum of the hydrogen atom. Bohrmodel of a hydrogen atom - its postulates, derivation of the relations for the energy of the electron and radii of the different orbits, limitations of Bohr's model; Dual nature of matter, de Broglie's relationship. Heisenberg uncertainty principle. Elementary ideas of quantum mechanics, quantum mechanics, the quantum mechanical model of the atom, and its important features. Concept of atomic orbitals as one-electron wave functions: Variation of Ψ and Ψ^2 with r for 1s and 2s orbitals; various quantum numbers (principal, angular momentum, and magnetic quantum numbers) and their significance; shapes of s, p, and d - orbitals, electron spin, and spin quantum number: Rules for filling electrons in orbitals – Aufbau principle. Pauli's exclusion principle and Hund's rule, electronic configuration of elements, and extra stability of half-filled and completely filled orbitals.

UNIT 3: CHEMICAL BONDING AND MOLECULAR STRUCTURE: Kossel-Lewis approach to chemical bond formation, the 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 electronegativity. 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, the concept of hybridization involving s, p, and d orbitals; Resonance.
Molecular Orbital Theor-Its important features. LCAOs, types of molecular orbitals (bonding, antibonding), sigma and pi-bonds, molecular orbital electronic configurations of homonuclear diatomic molecules, the concept of bond order, bond length, and bond energy. Elementary idea of metallic bonding. Hydrogen bonding and its applications.
UNIT 4: CHEMICAL THERMODYNAMICS: Fundamentals of thermodynamics: System and surroundings, extensive and intensive properties, state functions, Entropy, types of processes.
The 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, ionization, and solution.

The second law of thermodynamics-Spontaneity of processes; ΔS of the universe and ΔG of the system as criteria for spontaneity. ΔG° (Standard Gibbs energy change) and equilibriumconstant.

UNIT 5: SOLUTIONS: Different methods for expressing the concentration of solution - molality, molarity, mole fraction, percentage (by volume and mass both), the vapour pressure of solutions and Raoult'sLaw - Ideal and non-ideal solutions, vapour pressure - composition, plots for ideal and non- ideal solutions; Colligative properties of dilute solutions - a relative lowering of vapour pressure, depression of freezing point, the elevation of boiling point and osmotic pressure; Determination of molecular mass using colligative properties; Abnormal value of molar mass,Van't Hoff factor and its significance.

UNIT 6: EQUILIBRIUM: Meaning of equilibrium is the concept of dynamic equilibrium.
Equilibria involving physical processes: Solid-liquid, liquid-gas - gas and solid-gas equilibria, Henry's law. General characteristics of equilibrium involving physical processes. **Equilibrium involving chemical processes:** Law of chemical equilibrium, equilibrium constants (K_p and K_c) and their significance, the significance of ΔG and ΔG° in chemical equilibrium, factors affecting equilibrium concentration, pressure, temperature, the effect of catalyst; Le Chatelier's principle. **Ionic equilibrium:** Weak and strong electrolytes, ionization of electrolytes, various concepts of acids and bases (Arrhenius. 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, the solubility of sparingly soluble salts and solubility products, and buffer solutions.

UNIT 7: REDOX REACTIONS AND ELECTROCHEMISTRY: Electronic concepts of oxidation and reduction, redox reactions, oxidation number, rules for assigning oxidation number, and balancing of redox reactions. Electrolytic and metallic conduction, conductance in electrolytic solutions, 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 Galvaniccell and its measurement: Nernst equation and its applications; Relationship between cell potential and Gibbs' energy change: Dry cell and lead accumulator; Fuel cells.

UNIT 8: CHEMICAL KINETICS: Rate of a chemical reaction, factors affecting the rate of reactions: concentration, temperature, pressure, and catalyst; elementary and complex reactions, order and molecularity of reactions,rate law, rate constant and its units, differential and integral forms of zero and first-order reactions, their characteristics and half-lives, the effect of temperature on the rate of reactions,Arrhenius theory, activation energy and its calculation, collision theory of bimolecular gaseousreactions (no derivation).

INORGANIC CHEMISTRY

UNIT 9: CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES: Modem periodic law and present form of the periodic table, 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.

UNIT 10: P- BLOCK ELEMENTS: Group -13 to Group 18 Elements; General Introduction: Electronic configuration and general trends in physical and chemical properties of elements across the periods and down the groups; unique behaviour of the first element in each group.

UNIT 11: d - and f- BLOCK ELEMENTS: Transition Elements; General introduction, electronic configuration, occurrence and characteristics, general trends in properties of the first-row transition elements - physical properties, ionization enthalpy, oxidation states, atomic radii, colour, catalytic behaviour, magnetic properties, complexformation, interstitial compounds, alloy formation; Preparation, properties, and uses of $K_2Cr_2O_7$, and $KMnO_4$.

Inner Transition Elements: Lanthanoids - Electronic configuration, oxidation states, and lanthanoid contraction. **Actinoids** - Electronic configuration and oxidation states.

UNIT 12: CO-ORDINATION COMPOUNDS: Introduction to coordination compounds. Werner's theory; ligands, coordination 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).

ORGANIC CHEMISTRY

UNIT 13: PURIFICATION AND 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. **Quantitative analysis** (basic principles only) - Estimation of carbon, hydrogen, nitrogen, halogens, sulphur, and phosphorus. Calculations of empirical formulae and molecular formulae: Numerical problems in organic quantitative analysis.

UNIT 14: 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: and those containing halogens, oxygen, nitrogen, and sulphur; Homologous series: Isomerism - structural and stereoisomerism. **Nomenclature (Trivial and IUPAC)** Covalent bond fission - Homolytic and heterolytic: free radicals, carbocations, and carbanions; stability of carbocations and free radicals, electrophiles, and nucleophiles. **Electronic displacement in a covalent bond**- Inductive effect, electromeric effect, resonance, and hyperconjugation. **Common types of organic reactions** - Substitution, addition, elimination, and rearrangement.

UNITS 15: HYDROCARBONS

Classification, isomerism, IUPAC nomenclature, general methods of preparation, properties, and reactions. **Alkanes** - Conformations: Sawhorse and Newman projections (of ethane): Mechanism of halogenation of alkanes. **Alkenes** - Geometrical isomerism: Mechanism of electrophilic addition: addition of hydrogen, halogens, water, hydrogen halides (Markownikoffs 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 electrophilic substitution: halogenation, nitration. Friedel-Craft's alkylation and acylation, directive influence of the functional group in mono- substituted benzene.

UNIT 16: 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 freons, and DDT.

UNIT 17: ORGANIC COMPOUNDS CONTAINING OXYGEN: General methods of preparation, properties, reactions, and uses.

ALCOHOLS, PHENOLS, AND ETHERS

Alcohols: Identification of primary, secondary, and tertiary alcohols: mechanism of dehydration. **Phenols:** Acidic nature, electrophilic substitution reactions: halogenation. 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. NH_3, and its derivatives), Grignard reagent; oxidation: reduction (Wolf Kishner and Clemmensen); the acidity of α-hydrogen. aldol condensation, Cannizzaro reaction. Haloform reaction, Chemical tests

to distinguish between aldehydes and Ketones. **Carboxylic Acids:** Acidic strength and factors affecting it.

UNIT 18: 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.

UNIT 19: BIOMOLECULES: General introduction and importance of biomolecules. ARBOHYDRATES - Classification; aldoses and ketoses: monosaccharides (glucose and fructose) and constituent monosaccharides of oligosaccharides (sucrose, lactose, and maltose). PROTEINS - Elementary Idea of α-amino acids, peptide bond, polypeptides. Proteins: primary, secondary, tertiary, and quaternary structure (qualitative idea only), denaturation of proteins, enzymes. VITAMINS – Classification and functions. NUCLEIC ACIDS – Chemical constitution of DNA and RNA.Biological functions of nucleic acids. Hormones (General introduction).

UNIT 20: PRINCIPLES RELATED TO PRACTICAL CHEMISTRY: Detection of extra elements (Nitrogen, Sulphur, halogens) in organic compounds; Detection of the following functional groups; hydroxyl (alcoholic and phenolic), carbonyl (aldehyde and ketones) carboxyl, and amino groups in organic compounds. The chemistry involved in the preparation of the following: Inorganic compounds; Mohr's salt, potash alum. Organic compounds: Acetanilide, p-nitro acetanilide, aniline yellow, iodoform. The chemistry involved in the titrimetric exercises – Acids, bases, and the use of indicators, oxalic-acid. Chemical principles involved in the following experiments:

1. Enthalpy of solution of $CuSO_4$
2. Enthalpy of neutralization of strong acid and strong base.
3. Preparation of lyophilic and lyophobic sols.
4. Kinetic study of the reaction of iodide ions with hydrogen peroxide at room temperature.

03 Year Diploma in Mechanical Engineering (Production)

Syllabus comprises Physics, Chemistry, and Biology/Mathematics of High-school level.

Question Paper Pattern (All Parts are Compulsory)	Time: 02 Hours	Physics	Chemistry	Mathematics
	Total: 100 MCQs	**25**	**25**	**50**

Syllabus

Physics: Motion, Heat, Force, Work, Energy, Gravitation Microscope, Magnetic effect of Electric current, domestic electric circuit, Wave motion, Solar family, Human eye, Universe.

Chemistry: Types of matter and difference in their nature. Classification of matter. Air, Types of fuel, Human dependence on natural resources, Necessity of balanced diet, Electro-chemical Cell, Electrolysis, Chemical bonds, Mineral cycle, Physical and chemical change, Ecological balance.

Mathematics: Real Numbers, Polynomials, Couple of two variable linear equations, Quadratic equations, Arithmetic progression, Triangle, Coordinate Geometry, Introduction of Trigonometry, Some applications of Trigonometry, Construction of Circle, Area of Circle, Surface area and volume, Statistics and Probability.