ANNEXURE - I

SYLLABUS FOR THE ENTRANCE EXAMINATIONS, 2019

(See Clause 9.5.1)

MATHEMATICS

UNIT I: ALGEBRA

SETS, RELATIONS AND FUNCTIONS

Sets and their Representations: Finite and Infinite sets; Empty set; Equal sets; Subsets; Power set; Universal set; Venn Diagrams; Complement of a set; Operations on Sets (Union, Intersection and Difference of Set); Applications of sets: Ordered Pairs, Cartesian Product of Two sets; Relations: Domain, Co-domain and Range: Functions: into, on to, one - one in to, one-one on to Functions; Constant Function; Identity Function; composition of Functions; Invertible Functions; Binary Operations.

Complex Numbers

Complex Numbers in the form $a+ib$; Real and Imaginary Parts of a complex Number; Complex Conjugate, Argand Diagram, Representation of Complex Number as a point in the plane; Modulus and Argument of a Complex Number; Algebra of Complex Numbers; Triangle Inequality; $|Z_1+Z_2|\leq|Z_1|+|Z_2|; |Z_1.Z_2|=|Z_1||Z_2|;$ Polar Representation of a Complex Number.

Quadratic Equations

Solution of a Quadratic Equation in the Complex Number System by (i) Factorization (ii) Using Formula; Relation between Roots and Coefficients; Nature of Roots; Formation of Quadratic Equations with given Roots; Equations Reducible to Quadratic Forms.

Sequences and Series

Sequence and Examples of Finite and Infinite Sequences; Arithmetic Progression (A..P): First Term, Common Difference, n^{th} Term and sum of n terms of an A.P.; Arithmetic Mean (A.M); Insertion of Arithmetic Means between any Two given Numbers; Geometric Progression (G.P): first Term, Common Ratio and nth term, Sum to n Terms, Geometric Mean (G.M); Insertion of Geometric Means between any two given Numbers.

Permutations, Combinations, Binomial Theorem and Mathematical Induction

Fundamental Principle of Counting; The Factorial Notation; Permutation as an Arrangement; Meaning of P(n, r); Combination: Meaning of C(n,r); Applications of Permutations and Combinations. Statement of Binomial Theorem; Proof of Binomial Theorem for positive integral Exponent using Principle of Mathematical Induction and also by combinatorial Method; General and Middle Terms in Binomial Expansions; Properties of Binomial Coefficients; Binomial Theorem for any Index (without proof); Application of Binomial Theorem. The Principle of Mathematical Induction, simple Applications.

Matrices and Determinants

Concept of a Matrix; Types of Matrices; Equality of Matrices (only real entries may be considered): Operations of Addition, Scalar Multiplication and Multiplication of Matrices; Statement of Important Results on operations of Matrices and their Verifications by Numerical Problem only; Determinant of a Square Matrix; Minors and Cofactors; singular and non-singular Matrices; Applications of Determinants in (i) finding the Area of a Triangle (ii) solving a system of Linear Equations (Cramer's Rule); Transpose, Adjoint and Inverse of a Matrix; Consistency and Inconsistency of a system of Linear Equations; Solving

System of Linear Equations in Two or Three variables using Inverse of a Matrix (only up to 3X3 Determinants and Matrices should be considered).

Linear Inequations

Solutions of Linear Inequation in one variable and its Graphical Representation; solution of system of Linear Inequations in one variable; Graphical solutions of Linear inequations in two variables; solutions of system of Linear Inequations in two variables.

Mathematical Logic and Boolean Algebra

Statements; use of Venn Diagram in Logic; Negation Operation; Basic Logical Connectives and Compound Statements including their Negations.

UNIT II : TRIGONOMETRY

Trigonometric functions and Inverse Trigonometric functions

Degree measures and Radian measure of positive and negative angles; relation between degree measure and radian measure, definition of trigonometric functions with the help of a unit circle, periodic functions, concept of periodicity of trigonometric functions, value of trigonometric functions of x for x = 0, $\pi/6$, $\pi/4$, $\pi/3$, $\pi/2$, π, $3\pi/2$, 2π; trigonometric functions of sum and difference of numbers.

$Sin(x \pm y) = Sin\,x\,Cos\,y \pm Cos\,x\,Sin\,y$; $\mathrm{Cos}(x \pm y) = Cos\,x\,Cos\,y \mp Sin\,x\,Sin\,y$; $Tan(x \pm y) = \dfrac{Tan\,x \pm Tan\,y}{1 \mp Tan\,x\,Tan\,y}$;

$\mathrm{Sin}(2\pi \pm x) = \pm Sin\,x$, $\mathrm{Cos}(2\pi \pm x) = Cos\,x$; $\mathrm{Cos}(-x) = Cos\,x$, $\mathrm{Sin}(-x) = -Sin\,x$; $Cos\left(\pi/2 \pm x\right) = \pm Sin\,x$

$\mathrm{Sin}\left(\pi/2 \pm x\right) = Cos\,x$; $\mathrm{Cos}(\pi \pm x) = -Cos\,x$, $\mathrm{Sin}(\pi \pm x) = \pm Sin\,x$

Trigonometric functions of multiple and submultiples of numbers.

$Sin\,2x = 2\,Sin\,x\,Cos\,x$;

$Sin3x = 3Sinx - 4\mathrm{Sin}^3x$; $Cos\,2x = \mathrm{Cos}^2x - Sin^2x = 1 - 2\,Sin^2x = 2\,Cos^2x - 1$; $Cos\,3x = 4\,\mathrm{Cos}^3x - 3\,Cos\,x$

$Tan\,3x = \dfrac{3\,\mathrm{Tan}\,x - \mathrm{Tan}^3x}{1 - 3Tan^2x}$; $Sin\,x + \mathrm{Sin}\,y = 2\,\mathrm{Sin}\left(\dfrac{x+y}{2}\right)Cos\left(\dfrac{x-y}{2}\right)$; $Cos\,x + \mathrm{Cos}\,y = 2\,\mathrm{Cos}\left(\dfrac{x+y}{2}\right)\mathrm{Cos}\left(\dfrac{x-y}{2}\right)$

$\mathrm{Sin}\,x - Sin\,y = 2\,\mathrm{Cos}\left(\dfrac{x+y}{2}\right)\mathrm{Sin}\left(\dfrac{x-y}{2}\right)$; $Cos\,x - \mathrm{Cos}\,y = -2\,\mathrm{Sin}\left(\dfrac{x+y}{2}\right)\mathrm{Sin}\left(\dfrac{x-y}{2}\right)$

Conditional identities for the angles of a triangle, solution of trigonometric equations of the type Sin x = Sin a ; Cos x = Cos a; Tan x = Tan a and equations reducible to these forms.

Inverse Trigonometric functions:

(i) $\mathrm{Sin}^{-1}(Sin\,x) = x$ and other similar formula (ii) $\mathrm{Sin}^{-1}\left(1/x\right) = Co\sec^{-1}x$ and other similar formula.

$Sin^{-1}(-x) = -Sin^{-1}x$, $Tan^{-1}(-x) = -Tan^{-1}x$; $Co\sec^{-1}(-x) = -Co\sec^{-1}x$, $Cos^{-1}(-x) = \pi - Cos^{-1}(x)$;

$Sec^{-1}(-x) = \pi - Sec^{-1}(x)$, $Cot^{-1}(-x) = \pi - Cot^{-1}(x)$

$Sin^{-1}x + Cos^{-1}x = \pi/2$, $\mathrm{Tan}^{-1}x + Cot^{-1}x = \pi/2$; $Co\sec^{-1}(x) + Sec^{-1}(x) = \pi/2$; $Tan^{-1}x - Tan^{-1}y = Tan^{-1}\left(\dfrac{x-y}{1+xy}\right)$, xy > -1

$Tan^{-1}x + Tan^{-1}y = Tan^{-1}\left(\dfrac{x+y}{1-xy}\right)$; xy < 1 ; $2\,Tan^{-1}x = Sin^{-1}\left(\dfrac{2x}{1+x^2}\right) = Cos^{-1}\left(\dfrac{1-x^2}{1+x^2}\right) = Tan^{-1}\left(\dfrac{2x}{1-x^2}\right)$, $|x| < 1$

Simple problems

Graph of the following trigonometric functions;

y = Sin x ; y = Cos x ; y = Tan x ; y = a Sin x ;y = a Cos x, y = a Sin bx ; y = a Cos bx;

UNIT III: GEOMETRY

Cartesian System of Rectangular Co ordinates

Cartesian system of co ordinates in a plane, Distance formula, Centroid and incentre, Area of a triangle, condition for the collinearity of three points in a plane, Slope of line, parallel and perpendicular lines, intercepts of a line on the co ordinate axes, Locus and its equation.

Lines and Family of lines

Various forms of equations of a line parallel to axes, slope-intercept form, The Slope point form, Intercept form, Normal form, General form, Intersection of lines. Equation of bisectors of angle between two lines, Angles between two lines, condition for concurrency of three lines, Distance of a point from a line, Equations of family of lines through the intersection of two lines.

Circles and Family of circles

Standard form of the equation of a circle General form of the equation of a circle, its radius and center, Equation of the circle in the parametric form.

Conic sections

Sections of a cone. Equations of conic sections [Parabola, Ellipse and Hyperbola] in standard form.

Vectors

Vectors and scalars, Magnitude and Direction of a vector, Types of vectors (Equal vectors, unit vector, Zero vector). Position vector of a point, Localized and free vectors, parallel and collinear vectors, Negative of a vector, components of a vector, Addition of vectors, multiplication of a vector by a scalar, position vector of point dividing a line segment in a given ratio, Application of vectors in geometry. Scalar product of two vectors, projection of a vector on a line, vector product of two vectors.

Three Dimensional Geometry

Coordinate axes and coordinate planes in three dimensional space, coordinate of a point in space, distance between two points, section formula, direction cosines, and direction ratios of a line joining two points, projection of the join of two points on a given line, Angle between two lines whose direction ratios are given, Cartesian and vector equation of a line through (i) a point and parallel to a given vector (ii) through two points, Collinearity of three points, coplanar and skew lines, Shortest distance between two lines, Condition for the intersection of two lines, Carterian and vector equation of a plane (i) When the normal vector and the distance of the plane from the origin is given (ii) passing though a point and perpendicular to a given vector (iii) Passing through a point and parallel to two given lines through the intersection of two other planes (iv) containing two lines (v) passing through three points, Angle between (i) two lines (ii) two planes (iii) a line and a plane, Condition of coplanarity of two lines in vector and Cartesian form, length of perpendicular of a point from a plane by both vector and Cartesian methods.

UNIT IV: STATISTICS

Statistics and probability

Mean deviation for ungrouped data, variance for grouped an ungrouped data, standard deviation. Random experiments and sample space, Events as subset of a sample space, occurrence of an event, sure and impossible events, Exhaustive events, Algebra of events, Meaning of equality likely outcomes, mutually exclusive events. Probability of an event; Theorems on probability; Addition rule, Multiplication rule, Independent experiments and events. Finding P (A or B), P (A and B), random variables, Probability distribution of a random variable.

UNIT V : CALCULUS

Functions, Limits and continuity

Concept of a real function; its domain and range; Modulus Function, Greatest integer function: Signum functions; Trigonometric functions and inverse trigonometric functions and their graphs; composite functions, Inverse of a function.

Limit of a function; meaning and related notations; Left and right hand limits; Fundamental theorems on limits without proof $\lim_{x\to a}\frac{x^n-a^n}{x-a}=na^{n-1}, a>0; \lim_{x\to 0}\frac{Sin\,x}{x}=1; \lim_{x\to 0}\frac{e^x-1}{x}=1$ (without proof); $\lim_{x\to 0}\frac{\log(1+x)}{x}=1$ Limits at Infinity and infinity limits; continuity of a function at a point, over an open/ closed interval; Sum, Product and quotient of continuous functions; Continuity of special functions- Polynomial, Trigonometric, exponential, Logarithmic and Inverse trigonometric functions.

Differentiation

Derivative of a function; its geometrical and physical significance; Relationship between continuity and differentiability; Derivatives of polynomial, basic trigonometric, exponential, logarithmic and inverse trigonometric functions from first principles; derivatives of sum, difference, product and quotient of functions; derivatives of polynomial, trigonometric, exponential, logarithmic, inverse trigonometric and implicit functions; Logarithmic differentiation; derivatives of functions expressed in parametric form; chain rule and differentiation by substitution; Derivatives of Second order.

Application of Derivatives

Rate of change of quantities; Tangents and Normals; increasing and decreasing functions and sign of the derivatives; maxima and minima; Greatest and least values; Rolle's theorem and Mean value theorem; Approximation by differentials.

Indefinite Integrals

Integration as inverse of differentiation; properties of integrals; Integrals involving algebraic, trigonometric, exponential and logarithmic functions; Integration by substitution; Integration by parts; Integrals of the type:

$$\int \frac{dx}{x^2 \pm a^2}, \int \frac{dx}{a^2 - x^2}, \int \frac{dx}{\sqrt{x^2 \pm a^2}}, \int \frac{dx}{\sqrt{a^2 - x^2}}, \int \frac{dx}{ax^2 + bx + c},$$

$$\int \frac{px+q}{ax^2 + bx + c} dx, \int \frac{dx}{\sqrt{ax^2 + bx + c}}, \int \frac{px+q}{\sqrt{ax^2 + bx + c}} \text{dx}.$$

Integration of rational functions; Partial fractions and their use in integration; Integrals of the type

$$\int \sqrt{x^2 \pm a^2}\ dx, \int \sqrt{a^2 - x^2}\, dx, \int \sqrt{\left(ax^2 + bx + c\right)}\, dx, \int (px+q)\sqrt{(ax^2 + bx + c)}\ dx,$$

$$\int \frac{dx}{a + b\cos x}, \int \frac{dx}{a - b\sin x}, \int Sin^{-1} x\, dx, \int \log x\, dx.$$

Definite Integrals

Definite integral as limit of a sum; Fundamental theorems of integral calculus without proof); Evaluation of definite integrals by substitution and by using the following properties.

$$\int_a^b f(x)\, dx = -\int_b^a f(x)\, dx \ ; \int_a^b f(x)\, dx = \int_a^c f(x)\, dx + \int_c^b f(x)\, dx$$

$$\int_a^b f(x)\, dx = \int_a^b f(a + b - x)\, dx \ ; \int_0^a f(x)\, dx = \int_0^a f(a - x)\, dx$$

$$\int_a^b f(x)\, dx = \int_a^b f(a+b-x)\, dx \ ; \int_0^a f(x)\, dx = \int_0^a f(a-x)\, dx$$

$$\int_a^b f(x)\, dx = \int_a^b f(a+b-x)\, dx \ ; \int_0^a f(x)\, dx = \int_0^a f(a-x)\, dx$$

$$\int_0^{2a} f(x)\, dx = \int_0^a f(x)\, dx + \int_0^a f(2a-x)\, dx \ ; = \int_0^{2a} f(x)\, dx = 2\int_0^a f(x) dx, \ if\ f(2a-x) = f(x)$$

$$\int_0^{2a} f(x)\, dx = 0, \ if\ f(2a-x) = -f(x)$$

$$\int_{-a}^{a} f(x)\, dx = \begin{cases} 2\int_0^a f(x)\, dx\ , & if \quad f(x)\ is\ even \\ 0 \quad \text{if f(x)} \quad \text{is odd} \end{cases}$$

Application of definite integrals in finding areas bounded by a curve, circle, parabola and ellipse in standard form between two ordinates and x-axis; Area between two curves, line and circle; line and parabola: line and ellipse.

Differential Equations

Definition; order and degree; general and particular solutions of a differential equation; formation of differential equations whose general solution is given; solution of differential equations by method of Separation of variables; Homogeneous differential equations of first order and their solutions; Solution of linear differential equations of the type $\frac{dy}{dx} + P(x)\, y = Q(x)$ where P (x), Q (x) are functions of x.

PHYSICS

UNIT 1: INTRODUCTION AND MEASUREMENT

Physics – Scope and excitement; Physics in relation to science, society and technology – inventions, names of scientists and their fields, nobel prize winners and topics, current developments in physical sciences and related technology. Units for measurement – systems of units, S .I units, conversion from other systems to S.I units. Fundamental and derived units. Measurement of length, mass and time, least count in measuring instruments (eg. vernier calipers, screw gauge etc), Dimensional analysis and applications, order of magnitude, accuracy and errors in measurement, random and instrumental errors, significant figures and rounding off principles.

UNIT 2 : DESCRIPTION OF MOTION IN ONE DIMENSION

Objects in motion in one dimension – Motion in a straight line, uniform motion – its graphical representation and formulae; speed and velocity - instantaneous velocity; ideas of relative velocity with expressions and graphical representations; Uniformly accelerated motion, position – time graph, velocity – time graph and formulae. Elementary ideas of calculus – differentiation and integration – applications to motion.

UNIT 3 : DESCRIPTION OF MOTION IN TWO AND THREE DIMENSIONS

Vectors and scalars, vectors in two and three dimensions, unit vector, addition and multiplication, resolution of vector in a plane, rectangular components, scalar and vector products. Motion in two dimensions – projectile motion, ideas of uniform circular motion, linear and angular velocity, relation between centripetal acceleration and angular speed.

UNIT 4 : LAWS OF MOTION

Force and inertia, first law of motion, momentum, second law of motion, forces in nature, impulse, third law of motion, conservation of linear momentum, examples of variable mass situation, rocket propulsion, equilibrium of concurrent forces.

Static and kinetic friction, laws of friction, rolling friction, lubrication. Inertial and non-inertial frames (elementary ideas); Dynamics of uniform circular motion – centripetal and centrifugal forces, examples : banking of curves and centrifuge.

UNIT 5 : WORK, ENERGY AND POWER

Work done by a constant force and by a variable force, units of work – Energy – kinetic and potential forms, power, work-energy theorem. Elastic and inelastic collisions in one and two dimensions. Gravitational potential energy and its conversion to kinetic energy, spring constant, potential energy of a spring, Different forms of energy, mass – energy equivalence (elementary ideas), conservation of energy, conservative and non-conservative forces.

UNIT 6: MOTION OF SYSTEM OF PARTICLES AND RIGID BODY ROTATION

Centre of mass of a two particle system, generalisation to N particles, momentum conservation and center of mass motion, applications to some familiar systems, center of mass of rigid body. Moment of a force, torque, angular momentum, physical meaning of angular momentum, conservation of angular momentum with some examples, eg. planetary motion. Equilibrium of rigid bodies, rigid body rotation and equation of rotational motion, comparison of linear and rotational motions, moment of inertia and its physical significance, radius of gyration, parallel and perpendicular axes theorems (statements only), moment of inertia of circular ring and disc, cylinder rolling without slipping.

UNIT 7 : GRAVITATION

Universal law of gravitation, gravitational constant (G) and acceleration due to gravity (g), weight and gravitation, variation of g with altitude, latitude, depth and rotation of earth. Mass of earth, gravitational potential energy near the surface of the earth, gravitational potential, escape velocity, orbital velocity of satellite, weightlessness, motion of geostationary and polar satellites, statement of Kepler's laws of planetary motion, proof of second and third laws, relation between inertial and gravitational masses.

UNIT 8 : MECHANICS OF SOLIDS AND FLUIDS

Solids : Hooke's law, stress – strain relationships, Youngs modulus, bulk modulus, shear modulus of rigidity, some practical examples. **Fluids :** Pressure due to fluid column, Pascal's law and its applications (hydraulic lift and hydraulic brakes), effect of gravity on fluid pressure, Buoyancy, laws of floatation and Archimedes principles, atmospheric pressure. Surface energy and surface tension, angle

of contact, examples of drops and babbles, capillary rise, detergents and surface tension, viscosity, sphere falling through a liquid column, Stokes law, streamline flow, Reynold's number, equation of continuity, Bernoulli's theorum and applications.

UNIT 9 : HEAT AND THERMODYNAMICS

Kinetic theory of gases, assumptions, concept of pressure, kinetic energy and temperature, mean-rms and most probable speed, degrees of freedom, statement of law of equipartition of energy, concept of mean free path and Avogadros' number

Thermal equilibrium and temperatures, zeroth law of thermodynamics, Heat-work and internal energy, Thermal expansion – thermometry. First law of thermodynamics and examples, specific heat, specific heat of gases at constant volume and constant pressure, specific heat of solids, Dulong and Petit's law. Thermodynamical variables and equation of state, phase diagrams, ideal gas equation, isothermal and adiabatic processes, reversible and irreversible processes, Carnot engines, refrigerators and heat pumps, efficiency and coefficient performance of heat engines , ideas of second law of thermodynamics with practical applications. Thermal radiation – Stefan-Boltzmann law, Newton's law of cooling.

UNIT 10 : OSCILLATIONS

Periodic motion – period, frequency, displacement as a function of time and periodic functions; Simple harmonic motion (S.H.M) and its equation, uniform circular motion and simple harmonic motion, oscillations of a spring, restoring force and force constant, energy in simple harmonic motion, kinetic and potential energies, simple pendulum – derivation of expression for the period; forced and damped oscillations and resonance (qualitative ideas only), coupled oscillations.

UNIT 11: WAVES

Longitudinal and transverse waves, wave motion, displacement relation for a progressive wave, speed of a traveling wave, principle of superposition of waves, reflection of waves, standing waves in strings and pipes, fundamental mode and harmonics, beats, Doppler effect of sound with applications.

UNIT 12: ELECTROSTATICS

Frictional electricity; Properties of electric charges - conservation, additivity and quantisation. Coulomb's law – Forces between two point electric charges, Forces between multiple electric charges; Superposition principle and continuous charge distribution. Electric field and its physical significance, electric field due to a point charge, electric field lines; Electric dipole, electric field due to a dipole and behavior and dipole in a uniform electric field. Electric potential-physical meaning, potential difference, electric potential due to a point charge, a dipole and system of charges; Equipotential surfaces, Electrical potential energy of a system of point charges, electric dipoles in an electrostatic field. Electric flux, statement of Gauss' theorem-its application to find field due to an infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell. Conductors and insulators-presence of free charges and bound charges; Dielectrics and electric polarization, general concept of a capacitor and capacitance, combination of capacitors in series and in parallel, energy stored in a capacitor, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, Van de Graff generator.

UNIT 13: CURRENT ELECTRICITY

Electric current, flow of electric charges in a metallic conductor, drift velocity and mobility, their relation with electric current; Ohm's law, electrical resistance, V-I characteristics, limitations of Ohm's law, electrical resistivity and conductivity, classification of materials in terms of conductivity; Superconductivity (elementary idea); Carbon resistors, colour code for carbon resistors; combination of resistances - series and parallel. Temperature dependence of resistance. Internal resistance of a cell, Potential difference and emf of a cell, combination of cells in series and in parallel. Kirchoff's laws-illustration by simple applications, Wheatstone bridge and its applications, Meter bridge. Potentiometer - principle and applications to measure potential difference, comparison of emf of two cells and determination of internal resistance of a cell. Electric power, thermal effects of current and Joule's law; Chemical effects of current, Faraday's laws of electrolysis, Electro-chemical cells.

UNIT 14: MAGNETIC EFFECT OF CURRENT AND MAGNETISM

Concept of a magnetic field, Oersted's experiment, Biot-Savart's law, magnetic field due to an infinitely long current carrying straight wire and a circular loop, Ampere's circuital law and its applications to straight and toroidal solenoids. Force on a moving charge in a uniform magnetic field, cyclotron. Force on current carrying conductor and torque on current loop in magnetic fields, force between two parallel current carrying conductors, definition of the ampere. Moving coil galvanometer

and its conversion into ammeter and voltmeter. Current loop as a magnetic dipole, magnetic moment, torque on a magnetic dipole in a uniform magnetic field, Lines of force in magnetic field. Comparison of a bar magnet and solenoid. Earth's magnetic field and magnetic elements, vibration magnetometer. Para, dia and ferromagnetic substances with examples. Electromagnets and permanent magnets.

UNIT 15: ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENT

Electromagnetic induction, Faraday's laws, Induced e.m.f. and current, Lenz's law, Eddy currents, self and mutual inductance. Alternating current, peak and rms value of alternating current/voltage, reactance and impedance, L.C. oscillations, LCR series circuit. (Phasor diagram), Resonant circuits and Q-factor; power in A.C. circuits, wattless current.

AC generator and Transformer.

UNIT 16: ELECTROMAGNETIC WAVES

Properties of electromagnetic waves and Maxwell's contributions (qualitative ideas), Hertz's experiments, Electromagnetic spectrum (different regions and applications), propagation of electromagnetic waves in earth's atmosphere.

UNIT 17: OPTICS

Reflection in mirrors, refraction of light, total internal reflection and its applications, spherical lenses, thin lens formula, lens maker's formula; Magnification, Power of a lens, combination of thin lenses in contact; Refraction and dispersion of light due to a prism, Scattering of light, Blue colour of the sky and appearance of the sun at sunrise and sunset. Optical instruments, Compound microscope, astronomical telescope (refraction and reflection type) and their magnifying powers. Wave front and Huygen's principle. Reflection and refraction of plane wave at a plane surface using wave fronts (qualitative idea); 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, difference between interference and diffraction, resolving power of microscope and telescope; Polarisation, plane polarised light, Brewster's law, Use of polarised light and polaroids.

UNIT 18: DUAL NATURE OF MATTER AND RADIATIONS

Photoelectric effect, Einstein photoelectric equation - particle nature light, photo-cell, Matter waves - wave nature of particles. De Broglie relation, Davisson and Germer experiment.

UNIT 19: ATOMIC NUCLEUS

Alpha particle scattering experiment, size of the nucleus - composition of the nucleus - protons and neutrons. Nuclear instability - Radioactivity-Alpha, Beta and Gamma particle/rays and their properties, radio- active decay laws, Simple explanation of ▫□-decay, ▫-decay and ▫□decay; mass-energy relation, mass defect, Binding energy per nucleon and its variation with mass number. Nature of nuclear forces, nuclear reactions, nuclear fission, nuclear reactors and their uses; nuclear fusion, elementary ideas of energy production in stars.

UNIT 20: SOLIDS AND SEMICONDUCTOR DEVICES

Energy bands in solids (qualitative ideas only), difference between metals, insulators and semi-conductors using band theory; Intrinsic and extrinsic semi-conductors, p-n junction, Semi-conductor diode-characteristics forward and reverse bias, diode as a rectifier, solar cell, photo-diode, zener diode as a voltage regulator; Junction transistor, characteristics of a transistor; Transistor as an amplifier (common emitter configuration) and oscillator; Logic gates (OR, AND, NOT, NAND, NOR); Elementary ideas about integrated circuits.

UNIT 21: PRINCIPLES OF COMMUNICATIONS

Elementary idea of analog and digital communication; Need for modulation, amplitude, frequency and pulse modulation; Elementary ideas about demodulation, Data transmission and retrieval, Fax and Modem. (basic principles) Space communications - Ground wave, space wave and sky wave propagation, satellite communications.

CHEMISTRY

UNIT 1: BASIC CONCEPTS AND ATOMIC STRUCTURE

Laws of chemical combination: Law of conservation of mass. Law of definite proportion. Law of multiple proportions. Gay-Lussac's law of combining volumes. Dalton's atomic theory. Mole concept. Atomic, molecular and molar masses. Chemical equations. Balancing and calculation based on chemical equations.

Atomic structure: Fundamental particles. Rutherford model of atom. Nature of electromagnetic radiation. Emission spectrum of hydrogen atom. Bohr model of hydrogen atom. Drawbacks of Bohr model. Dual nature of matter and radiation. de Broglie relation. Uncertainty principle. Wave function (mention only). Atomic orbitals and their shapes (s, p and d orbitals only). Quantum numbers. Electronic configurations of elements. Pauli's exclusion principle. Hund's rule. Aufbau principle.

UNIT 2: BONDING AND MOLECULAR STRUCTURE

Kossel and Lewis approach of bonding. Ionic bond, covalent character of ionic bond, Lattice energy. Born-Haber cycle. Covalent bond. Lewis structure of covalent bond. Concept of orbital overlap. VSEPR theory and geometry of molecules. Polarity of covalent bond. Valence bond theory and hybridization (sp, sp^2, sp^3, dsp^2, d^2sp^3 and sp^3d^2). Resonance. Molecular orbital method. Bond order. Molecular orbital diagrams of homodiatomic molecules. Bond strength and magnetic behaviour. Hydrogen bond. Coordinate bond. Metallic bond.

UNIT 3: STATES OF MATTER

Gaseous state: Boyle's law. Charles' law. Avogadro's hypothesis. Graham's law of diffusion. Absolute scale of temperature. Ideal gas equation. Gas constant and its values. Dalton's law of partial pressure. Aqueous tension. Kinetic theory of gases. Deviation of real gases from ideal behaviour. Inter molecular interaction, van der Waals equation. Liquefaction of gases. Critical temperature.

Liquid state: Properties of liquids. Vapour pressure and boiling point. Surface tension. Viscosity.

Solid state: Types of solids (ionic, covalent and molecular). Space lattice and unit cells. Cubic crystal systems. Close packing. Different voids (tetrahedral and octahedral only). Density calculations. Point defects (Frenkel and Schottky). Electrical properties of solids. Conductors, semiconductors and insulators. Piezoelectric and pyroelectric crystals. Magnetic properties of solids. Diamagnetic, paramagnetic, ferromagnetic, antiferromagnetic and ferrimagnetic substances.

UNIT 4: PERIODIC PROPERTIES OF ELEMENTS AND HYDROGEN

Classification of elements: Mendeleev's periodic table. Atomic number and modern periodic law. Long form of periodic table. Electronic configurations of elements and their position in the periodic table. Classification into s-, p-, d- and f-block elements. **Periodic properties:** Ionization energy, electron affinity, atomic radii, valence and electro negativity.

Hydrogen: Position in the periodic table, occurrence, isolation, preparation (including commercial), properties, reactions and uses. Isotopes of hydrogen. **Hydrides:** Molecular, saline and interstitial hydrides. **Water:** Structure of water molecule and its aggregates. Physical and chemical properties of water. Hard and soft water. Removal of hardness. Preparation and uses of heavy water: Liquid hydrogen as fuel.

UNIT 5: S-BLOCK ELEMENTS AND PRINCIPLES OF METALLURGY

Alkali metals: Occurrence, electronic configuration, trends in atomic and physical properties (ionization energy, atomic radii and ionic radii), electrode potential, and reactions with oxygen, hydrogen, halogens and liquid ammonia. Oxides, hydroxides and halides.

Alkaline earth metals: Occurrence, electronic configuration, trends in atomic and physical properties, electrode potential, and reactions with oxygen, hydrogen and halogens. Oxides, hydroxides, halides and sulphides.

Anomalous properties of lithium and beryllium. **Compounds of s-block elements:** Large scale preparation of NaOH and Na_2CO_3, their properties and uses. Preparation and properties of CaO, $Ca(OH)_2$, Plaster of Paris and $MgSO_4$. Industrial uses of lime, limestone and cement.

Principles of metallurgy: Occurrence of metals. Concentration of ores. General principles of extraction of metals from ore. Thermodynamic and electro chemical principles of metallurgy. Refining of metals. Extraction of zinc, aluminium, iron and copper.

UNIT 6: P-BLOCK ELEMENTS

General characteristics of p-block elements: atomic and physical properties. Oxidation states. Trends in chemical reactivity of Groups 13, 14, 15, 16 and 17 elements.

Boron: Occurrence, isolation, physical and chemical properties. Borax and boric acid. Boron hydrides. Structure of diborane. Uses of boron and its compounds. **Carbon:** Allotropes, properties, Oxides of Carbon. **Nitrogen:** Terrestrial abundance and distribution, isolation, properties and chemical reactivity. **Ammonia:** Haber process of manufacture, properties and uses. **Nitric acid:** Ostwald process of manufacture and important uses. **Oxides of nitrogen:** Preparation and structures (skeletal only). **Oxygen:** Terrestrial abundance, isolation, properties and chemical reactivity. **Oxides:** Acidic, basic and amphoteric oxides. Preparation, structure, properties and uses of ozone and hydrogen peroxide.

Silica: Different forms and uses. Structures of silicates. Silicones, Zeolites, Uses of Silicon Tetra Chloride. **Phosphorus:** Production, allotropes and phosphine. Preparation and structures of PCl_3, PCl_5, oxyacids of phosphorus. Comparison of halides and hydrides of Group 15 elements. **Sulphur:** Production, allotropes, oxides and halides, Oxoacids of Sulphur (structure only). **Sulphuric acid:** Manufacture, properties and uses. Comparison of oxides, halides and hydrides of Group 17 elements, Oxoacids of halogens (structure only), hydrides and oxides of chlorine. Interhalogen compounds.

Group 18 elements: Occurrence, isolation, atomic and physical properties, uses. **Compounds of xenon**: Preparation of fluorides and oxides, and their reactions with water.

UNIT 7: D-BLOCK AND F-BLOCK ELEMENTS

d-Block elements: Electronic configuration and general characteristics. Metallic properties, ionization energy, electrode potential, oxidation states, ionic radii, catalytic properties, coloured ions, complex formation, magnetic properties, interstitial compounds and alloys. Preparation and properties of $KMnO_4$, $K_2Cr_2O_7$.

f-Block elements: Lanthanides: Occurrence, electronic configuration and oxidation states. Lanthanide contraction. Uses. **Actinides:** Occurrence, electronic configuration and comparison with lanthanides.

UNIT 8: THERMODYNAMICS

System and surrounding: Types of systems. Types of processes. Intensive and extensive properties. State functions and path functions. Reversible and irreversible processes. **First law of thermodynamics:** Internal energy and enthalpy. Application of first law of thermodynamics. Enthalpy changes during phase transition. Enthalpy changes in chemical reactions. Standard enthalpy of formation. Hess's law of constant heat summation and numerical problems. Heat capacity and specific heat. **Second law of thermodynamics:** Entropy and Gibbs free energy. Free energy change and chemical equilibrium. Criteria for spontaneity.

UNIT 9: CHEMICAL EQUILIBRIUM

Physical and chemical equilibria: Dynamic nature of equilibrium. Equilibria involving physical changes (solid-liquid, liquid-gas, dissolution of solids in liquids and dissolution of gases in liquids). General characteristics of equilibria involving physical processes. **Equilibria involving chemical systems:** Law of chemical equilibrium. Magnitude of equilibrium constant. Numerical problems. Effect of changing conditions of systems at equilibrium (changes of concentration, temperature and pressure). Effect of catalyst. The Le Chatelier principle and its applications. Relationship between K_p and K_c. Ionic equilibrium. Ionization of weak and strong electrolytes. **Concepts of acids and bases:** Those of Arrhenius, Bronsted-Lowry and Lewis. Acid-base equilibrium. Ionization of water. pH scale. Salt hydrolysis. Solubility product. Common ion effect. Buffer action and buffer solutions.

UNIT 10: SOLUTIONS

Types of solutions: Different concentration terms (normality, molarity, molality, mole fraction and mass percentage). Solubility of gases and solids. Vapour pressure of solutions and Raoult's law. Deviation from Raoult's law. **Colligative properties**: Lowering of vapour pressure, elevation in boiling point, depression in freezing point and osmotic pressure. Ideal and non-ideal solutions. Determination of molecular mass. Abnormal molecular mass. The van't Hoff factor and related numerical problems.

UNIT 11: REDOX REACTIONS AND ELECTROCHEMISTRY

Oxidation and reduction: Electron transfer concept. Oxidation number. Balancing equations of redox reactions: Oxidation number method and ion electron method (half reaction method).

Faraday's laws of electrolysis: Quantitative aspects. Electrolytic conduction. Conductance. Molar conductance. Kohlrausch's law and its applications. Electrode potential and electromotive force (e.m.f.). Reference electrode (SHE only). Electrolytic and Galvanic cells. Daniel cell. The Nernst equation. Free energy and e.m.f. Primary and secondary cells. Fuel cell (H_2-O_2 only). **Corrosion and its prevention:** Electrochemical theory of rusting of iron. Methods of prevention of corrosion. Galvanization and cathodic protection.

UNIT 12: CHEMICAL KINETICS

Rate of reaction. Average and instantaneous rates. Rate expressions. Rate constant. Rate law. Order and molecularity. Integrated rate law expressions for zero and first order reactions and their derivations. Units of rate constant. Half life period. Temperature dependence of rate constant. Arrhenius equation. Activation energy, Collision Theory (Elementary theory) and related numerical problems. Elementary and complex reactions with examples.

UNIT 13: SURFACE CHEMISTRY

Adsorption: Physical and chemical adsorption. Factors affecting adsorption. Effect of pressure. Freundlisch adsorption isotherm. Catalysis. Enzymes. Zeolites. **Colloids:** Colloids and suspensions. Dispersion medium and dispersed phase. Types of colloids: Lyophobic, lyophilic, multimolecular, macromolecular and associated colloids. Preparation, properties and protection of colloids. Gold number. Hardy Schulze rule. Emulsions.

UNIT 14: COORDINATION COMPOUNDS AND ORGANOMETALLICS

Ligand. Coordination number. IUPAC nomenclature of coordination compounds mononuclear, Isomerism in coordination compounds. Geometrical, optical and structural isomerism. Bonding in coordination compounds. Werner's coordination theory. Valence bond approach. Hybridization and geometry. Magnetic properties of octahedral, tetrahedral and square planar complexes. Introduction to crystal field theory. Splitting of d orbitals in octahedral and tetrahedral fields (qualitative only). Importance of coordination compounds in qualitative analysis and biological systems such as chlorophyll, hemoglobin and vitamin B_{12} (structures not included).

UNIT 15: BASIC PRINCIPLES, PURIFICATION AND CHARACTERIZATION OF ORGANIC COMPOUNDS

Distinction between organic and inorganic compounds. Tetra valence of carbon. Catenation. Hybridization (sp, sp^2 and sp^3). Shapes of simple molecules. General introduction to naming of organic compounds. Trivial names and IUPAC nomenclature. Illustrations with examples. Structural isomerism. Examples of functional groups containing oxygen, hydrogen, sulphur and halogens. **Purification of carbon compounds:** Filtration, crystallization, sublimation, distillation, differential extraction and chromatography (column and paper only). **Qualitative analysis:** Detection of carbon, hydrogen, nitrogen and halogens. **Quantitative analysis:** Estimation of carbon, hydrogen, nitrogen, sulphur, phosphorus and halogens (principles only), and related numerical problems. Calculation of empirical and molecular formulae.

UNIT 16: HYDROCARBONS

Classification of hydrocarbons. **Alkanes and cycloalkanes:** Nomenclature and conformation of ethane. 3D structures and 2D projections (Sawhorse and Newman). **Alkenes and alkynes:** Nomenclature. Geometrical isomerism in alkenes. Stability of alkenes. General methods of preparation. Physical and chemical properties. Markownikoff's rule. Peroxide effect. Acidic character of alkynes. Polymerization reactions of dienes.

Aromatic hydrocarbons: Nomenclature. Isomerism. Benzene and its homologues. Structure of Benzene. Resonance. Delocalisation in benzene. Concept of aromaticity (an elementary idea). Chemical reactions of benzene. Polynuclear hydrocarbons and their toxicity.

UNIT 17: ORGANIC REACTION MECHANISM

Electronic displacement in a covalent bond: Inductive, electromeric, resonance and hyperconjugation effects. Fission of a covalent bond. Free radicals, electrophiles, nucleophiles, carbocations and carbanions.

Common types of organic reactions: Substitution, addition, elimination and rearrangement reactions. Illustrations with examples. Mechanism of electrophilic addition reactions in alkenes. Concept of delocalisation of electrons. Mechanism of electrophilic substitution reactions. Directive influence of substituents and their effect on reactivity (in benzene ring only).

UNIT 18: STEREOCHEMISTRY

Stereoisomerism: Geometrical isomerism and optical isomerism. Specific rotation. Chirality and chiral objects. Chiral molecules. Configuration and Fischer projections. Asymmetric carbon. Elements of symmetry. Compounds containing one chiral center. Enantiomers. Racemic form. Racemization. Compounds containing two chiral centers. Diastereo isomers. Meso form. Resolution.

UNIT 19: ORGANIC COMPOUNDS WITH FUNCTIONAL GROUPS CONTAINING HALOGENS

Haloalkanes and haloarenes: Nomenclature and general methods of preparation. Physical properties. Nature of C-X bond in haloalkanes and haloarenes. Chemical properties and uses of chloromethane and chlorobenzene. **Polyhalogen compounds:** Preparation and properties of chloroform and iodoform. Uses of some commercially important compounds (chloroform, iodoform, DDT, BHC and freon).

UNIT 20: ORGANIC COMPOUNDS WITH FUNCTIONAL GROUPS CONTAINING OXYGEN

Alcohols: Nomenclature. Important methods of preparation (from aldehydes, ketones, alkyl halides and hydration of alkenes). Manufacture of ethanol from molasses. Physical and chemical properties. Reactions with alkali metals and acids. Formation of alkenes, ethers and esters. Reactions with PX_3, PX_5, $SOCl_2$. Oxidation of alcohols. Dehydrogenation.

Phenols: Nomenclature. Preparation of phenol (from sodium benzenesulphonate, benzene diazoniumchloride and chlorobenzene). Physical and chemical properties of phenol. Acidity of phenol. Action of phenol with $FeCl_3$. Bromination, sulphonation and nitration of phenol.

Ethers: Nomenclature. Methods of preparation (from alcohols and alkyl halides). Williamson's synthesis. Physical and chemical properties. Formation of peroxides. Actions with HI, HF and H_2SO_4.

Some commercially important compounds: Methanol, ethanol (fermentation).

Aldehydes and ketones: Nomenclature. Electronic structure of carbonyl group. Methods of preparation (from alcohols, acid chlorides, ozonolysis of alkenes and hydration of alkynes). Friedel-Crafts acylation for acetophenone. General properties (physical and chemical) of aldehydes and ketones. Formation of paraldehyde and metaldehyde. Addition of $NaHSO_3$, NH_3 and its derivatives, Grignard reagent, HCN and alcohols. Oxidation reactions with Tollen's reagent and Fehling's solution. Oxidation of ketones. Reduction with $LiAlH_4$. Clemmensen reduction. Wolff- Kischner reduction. Aldol condensation. Cannizzaro reaction.

Carboxylic acid: Nomenclature. Electronic structure of –COOH. Methods of Preparation (from alcohols, aldehydes, ketones, alkyl benzenes and hydrolysis of cyanide). Physical properties. Effects of substituents on acid strength. Chemical reactions.

UNIT 21: ORGANIC COMPOUNDS WITH FUNCTIONAL GROUPS CONTAINING NITROGEN

Amines: Nomenclature. Primary, secondary and tertiary amines. Methods of preparation. Physical properties. Basic nature. Chemical reaction. Separation of primary, secondary and tertiary amines. Cyanides and isocyanides. Diazonium salts. Preparation and chemical reactions of benzene diazoniumchloride in synthetic organic chemistry.

UNIT 22: POLYMERS AND BIOMOLECULES

Polymers: Classification. Addition and condensation polymerization. Copolymerization. Natural rubber and vulcanization. Synthetic rubbers. Condensation polymers. Biopolymers. Biodegradable polymers. Some commercially important polymers: Polyethene, polystyrene, PVC, Teflon, PAN, BUNA-N, BUNA-S, neoprene, Terylene, glyptal, nylon-6, nylon-66 and Bakelite.

Biomolecules: Classification of carbohydrates. Structure and properties of glucose. **Reducing and non-reducing sugars:** Properties of sucrose, maltose and lactose (structures not included). **Polysaccharides:** Properties of starch and cellulose. **Proteins**: Amino acids. Zwitterions. Peptide bond. Polypeptides. Primary, secondary and tertiary structures of protein. Denaturation of proteins. Enzymes. Nucleic acids. Types of nucleic acids. DNA and RNA, and their chemical composition. Primary structure of DNA. Double helix. **Vitamins:** Classification and functions in biosystems.

UNIT 23: ENVIRONMENTAL CHEMISTRY AND CHEMISTRY IN EVERY DAY LIFE

Soil, water and air pollutions. Ozone layer. Smog. Acid rain. Green house effect and global warming. Industrial air pollution. Importance of green chemistry.

Chemicals in medicine and health care. Drug-target interaction, Analgesics, tranquillizers, antiseptics, antacids, antihistamines, antibiotics, disinfectants, antifertility drugs, chemicals in food, preservatives, artificial sweetening agents, antioxidants and edible colours, cleansing agents, soaps and synthetic detergents, antimicrobials.