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# KEAM SYLLABUS - 2024

## MATHEMATICS

### UNIT I: ALGEBRA

#### **Sets, Relations and Functions**

Sets and their representations: Finite and Infinite sets; Empty set; Equal sets; Subsets; 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, reflexive, symmetric, transitive and equivalence relations. Domain, Co-domain and Range: Functions: into, onto, one - one into, one-one onto Functions; Constant Function; Identity Function; composition of Functions; Invertible Functions.

#### **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 of a Complex Number; Algebra of Complex Numbers.

#### **Sequences and Series**

Geometric Progression (G.P): first Term, Common Ratio and  $n^{\text{th}}$  term, Sum to  $n$  Terms. Geometric Mean (G.M); Insertion of Geometric Means, Relation between AM and GM. between any two given numbers.

#### **Permutations, Combinations, Binomial Theorem**

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.

#### **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 finding the Area of a Triangle. 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  $3 \times 3$  Determinants and Matrices should be considered).

## Linear Inequalities

Solutions of Linear Inequalities in one variable and its Graphical Representation; solution of system of Linear Inequalities in one variable.

## 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  $x = 0, \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{2}, \pi, \frac{3\pi}{2}, 2\pi$ ; trigonometric functions of sum and difference of numbers.

$$\begin{aligned} \sin(x \pm y) &= \sin x \cos y \pm \cos x \sin y; \cos(x \pm y) = \cos x \cos y \mp \sin x \sin y; \tan(x \pm y) = \frac{\tan x \pm \tan y}{1 \mp \tan x \tan y}; \\ \sin(2\pi \pm x) &= \pm \sin x, \cos(2\pi \pm x) = \cos x; \cos(-x) = \cos x, \sin(-x) = -\sin x; \cos\left(\frac{\pi}{2} \pm x\right) = \pm \sin x \\ \sin\left(\frac{\pi}{2} \pm x\right) &= \cos x; \cos(\pi \pm x) = -\cos x, \sin(\pi \pm x) = \pm \sin x \end{aligned}$$

**Trigonometric functions of multiple and submultiples of numbers.**

$$\begin{aligned} \sin 2x &= 2 \sin x \cos x; \sin 3x = 3 \sin x - 4 \sin^3 x; \cos 2x = \cos^2 x - \sin^2 x = 1 - 2 \sin^2 x = 2 \cos^2 x - 1; \\ \cos 3x &= 4 \cos^3 x - 3 \cos x \\ \tan 3x &= \frac{3 \tan x - \tan^3 x}{1 - 3 \tan^2 x}; \sin x + \sin y = 2 \sin\left(\frac{x+y}{2}\right) \cos\left(\frac{x-y}{2}\right); \cos x + \cos y = 2 \cos\left(\frac{x+y}{2}\right) \cos\left(\frac{x-y}{2}\right) \\ \sin x - \sin y &= 2 \cos\left(\frac{x+y}{2}\right) \sin\left(\frac{x-y}{2}\right); \cos x - \cos y = -2 \sin\left(\frac{x+y}{2}\right) \sin\left(\frac{x-y}{2}\right) \end{aligned}$$

Inverse Trigonometric functions. Range, domain, principal value branch and graphs of inverse trigonometric functions.

(i)  $\sin^{-1}(\sin x) = x$  and other similar formula (ii)  $\sin^{-1}\left(\frac{1}{x}\right) = \operatorname{cosec}^{-1} x$  and other similar formula.

$$\sin^{-1}(-x) = -\sin^{-1} x, \tan^{-1}(-x) = -\tan^{-1} x; \operatorname{cosec}^{-1}(-x) = -\operatorname{cosec}^{-1} x, \cos^{-1}(-x) = \pi - \cos^{-1}(x);$$

$$\sec^{-1}(-x) = \pi - \sec^{-1}(x), \cot^{-1}(-x) = \pi - \cot^{-1}(x)$$

$$\sin^{-1} x + \cos^{-1} x = \frac{\pi}{2}, \tan^{-1} x + \cot^{-1} x = \frac{\pi}{2}; \operatorname{cosec}^{-1}(x) + \sec^{-1}(x) = \frac{\pi}{2};$$

$$\tan^{-1} x - \tan^{-1} y = \tan^{-1}\left(\frac{x-y}{1+xy}\right), xy > -1$$

$$\tan^{-1} x + \tan^{-1} y = \tan^{-1}\left(\frac{x+y}{1-xy}\right); xy < 1; 2 \tan^{-1} x = \sin^{-1}\left(\frac{2x}{1+x^2}\right) = \cos^{-1}\left(\frac{1-x^2}{1+x^2}\right) = \tan^{-1}\left(\frac{2x}{1-x^2}\right), |x| < 1$$

## Simple problems

**Graph of the following trigonometric functions;**

$$y = \sin x; y = \cos x; y = \tan x$$

## **UNIT III: GEOMETRY**

### **Lines**

Cartesian system of coordinates in a plane. Distance formula, Slope of line, parallel and perpendicular 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. Angles between two lines, condition for concurrency of three lines, Distance of a point from a line.

### **Conic sections**

Sections of a cone. Circles, standard form of the equation of a circle, its radius and centre. Equations of conic sections [Parabola, Ellipse and Hyperbola] in standard form and simple properties.

### **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, coplanar and skew lines, Shortest distance between two lines, Condition for the intersection of two lines,

## **Unit IV: STATISTICS**

### **Statistics and probability**

Mean deviation, variance, standard deviation for grouped and ungrouped data. 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  $P(A \text{ or } B)$ ,  $P(A \text{ and } B)$ , Bayes' theorem.

## **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

$$\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a} = na^{n-1}, a > 0; \lim_{x \rightarrow 0} \frac{\sin x}{x} = 1;$$

theorems on limits without proof

(without proof);

Continuity of a function at a point, 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; increasing and decreasing functions and sign of the derivatives; maxima and minima; Greatest and least values;

### **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:

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

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

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

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

### **Definite Integrals**

Fundamental theorems of integral calculus without proof; Evaluation of definite integrals by substitution and by using the following properties.

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

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

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

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

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

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

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

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; 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 or constants.

### Linear Programming

Introduction, related terminology such as constraints, Objective function, optimisation, different types of linear programming problems, graphical method of solution for problems in two variables, feasible and infeasible regions, feasible and infeasible solutions, optimal feasible solutions ( up to three non-trivial constraints).

## **PHYSICS**

### **UNIT I: UNITS & MEASUREMENT**

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.

### **UNIT II: KINEMATICS**

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 and position-time graphs, relations for uniformly accelerated motion (graphical treatment).

Elementary concepts of differentiation and integration for describing motion. Scalar and vector quantities: Position and displacement vectors, general vectors and notation, equality of vectors, multiplication of vectors by a real number; addition and subtraction of vectors.

Unit vectors. Resolution of a vector in a plane – rectangular components. Scalar and Vector products of Vectors. Motion in a plane. Cases of uniform velocity and uniform acceleration – projectile motion. Uniform circular motion.

### **UNIT III: 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 level circular road, vehicle on banked road).

### **UNIT IV: 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; conservation of mechanical energy (kinetic and potential energies); non-conservative forces; motion in a vertical circle, elastic and inelastic collisions in one and two dimension.

## **UNIT V: 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 a rigid body; centre of mass of uniform rod, circular ring, disc and sphere. Moment of a force, torque, angular momentum, conservation of angular momentum with some examples. Equilibrium of rigid bodies, rigid body rotation and equation of rotational motion, comparison of linear and rotational motions; moment of inertia, radius of gyration. Values of M.I. for simple geometrical objects (no derivation).

## **UNIT VI: GRAVITATION**

Kepler's laws of planetary motion. The universal law of gravitation. Acceleration due to gravity and its variation with altitude and depth.

Gravitational potential energy; gravitational potential. Escape velocity, orbital velocity of a satellite.

## **UNIT VII: PROPERTIES OF BULK MATTER**

Elastic behaviour, Stress-strain relationship, Hooke's law, Young's modulus, bulk modulus, shear, modulus of rigidity, poisson's ratio; elastic energy.

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, Reynold's number, streamline and turbulent flow. Critical velocity, Bernoulli's theorem and its applications.

Surface energy and surface tension, angle of contact, excess of pressure, application of surface tension ideas to drops, bubbles and capillary rise.

Heat, temperature, thermal expansion; thermal expansion of solids, liquids, and gases.

Anomalous expansion. Specific heat capacity:  $C_p$ ,  $C_v$  – calorimetry; change of state – latent heat.

Heat transfer – conduction and thermal conductivity, convection and radiation.

Qualitative ideas of Black Body Radiation, Wein's displacement law, and Green House effect. Newton's law of cooling and Stefan's law.

## **UNIT VIII: THERMODYNAMICS**

Thermal equilibrium and definition of temperature (zeroth law of Thermodynamics). Heat, work and internal energy. First law of thermodynamics. Isothermal and adiabatic processes.

Second law of thermodynamics: Reversible and irreversible processes. Carnot Engine.



## **UNIT IX: BEHAVIOUR OF PERFECT GAS AND KINETIC THEORY**

Equation of state of a perfect gas, work done on compressing a gas. Kinetic theory of gases: Assumptions, concept of pressure.

Avogadro's number. Kinetic energy and 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.

## **UNIT X: OSCILLATIONS AND WAVES**

Periodic motion – period, frequency, displacement as a function of time. Periodic functions. Simple harmonic motion (SHM) and its equation; phase; oscillations of a spring – restoring force and force constant; energy in SHM – kinetic and potential energies; simple pendulum – derivation of expression for its time period;

Wave motion. Longitudinal and transverse waves, speed of wave motion. 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 XI: ELECTROSTATICS**

Electric charges and their conservation. Coulomb's law – force 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, statement of Gauss's theorem 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 (field inside and outside).

Electric potential, potential difference, electric potential due to a point charge, a dipole and system of charges; equipotential surfaces, electrical potential energy of a system of two point charges and of electric dipoles in an electrostatic field.

Conductors and insulators, free charges and bound charges inside a conductor. Dielectrics and electric polarisation, capacitors and capacitance, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, energy stored in a capacitor.

## **UNIT XII: CURRENT ELECTRICITY**

Electric current, flow of electric charges in a metallic conductor, drift velocity and mobility, and their relation with electric current; Ohm's law, electrical resistance, V-I

characteristics (linear and non-linear), electrical energy and power, electrical resistivity and conductivity.

Temperature dependence of resistance.

Internal resistance of a cell, potential difference and emf of a cell, combination of cells in series and in parallel.

Kirchhoff's laws and simple applications. Wheatstone bridge.

### **UNIT XIII: MAGNETIC EFFECTS OF CURRENT AND MAGNETISM**

Concept of magnetic field, Oersted's experiment.

Biot - Savart law and its application to current carrying circular loop.

Ampere's law and its applications to infinitely long straight wire, straight solenoids. Force on a moving charge in uniform magnetic and electric fields. Cyclotron.

Force on a current-carrying conductor in a uniform magnetic field. Force between two parallel current-carrying conductors – definition of ampere.

Torque experienced by a current loop in a magnetic field; moving coil galvanometer – its current sensitivity and conversion to ammeter and voltmeter.

Current loop as a magnetic dipole and its magnetic dipole moment. Magnetic dipole moment of a revolving electron. Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis. Torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid.

Magnetic field lines

Para-, dia- and ferro - magnetic substances, with examples

### **UNIT XIV: ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS**

Electromagnetic induction; Faraday's law, induced emf and current; Lenz's Law, 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 XV: ELECTROMAGNETIC WAVES**

Need for displacement current. Electromagnetic waves and their characteristics (qualitative ideas only). Transverse nature of electromagnetic waves.

Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, x-rays, gamma rays) including elementary facts about their uses.

### **UNIT XVI: OPTICS**

Reflection of light, spherical mirrors, mirror formula. Refraction of light, total internal reflection and its applications, optical fibres, refraction at spherical surfaces, lenses, thin lens formula, lens- maker's formula. Magnification, power of a lens, combination of thin lenses in contact combination of a lens and a mirror. Refraction and dispersion of light through a prism, Optical instruments

Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers.

Wave optics: Wavefront and Huygens' principle, reflection and refraction of plane wave at a plane surface using wavefronts. Proof of laws of reflection and refraction using Huygens' principle. Interference, Young's double hole experiment and expression for fringe width, coherent sources and sustained interference of light.

Diffraction due to a single slit, width of central maximum.

Polarisation, plane polarised light; uses of plane polarised light and Polaroids.

## **UNIT XVII: DUAL NATURE OF MATTER AND RADIATION**

Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation – particle nature of light.

Matter waves – wave nature of particles, De Broglie relation.

## **UNIT XVIII: 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, isotopes, isobars; isotones. Radioactivity – alpha, beta and gamma particles/rays and their properties; radioactive decay law. Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number; nuclear fission and fusion.

## **UNIT XIX: ELECTRONIC DEVICES**

Energy bands in solids (qualitative ideas only), conductors, insulators and semiconductors; semiconductor diode – I-V characteristics in forward and reverse bias, diode as a rectifier.

## **CHEMISTRY**

### **UNIT 1: SOME BASIC CONCEPTS OF CHEMISTRY**

General Introduction: Importance and scope of chemistry. Historical approach to particulate nature of matter, laws of chemical combination, Dalton's atomic theory: concept of elements, atoms and molecules. Atomic and molecular masses. Mole concept and molar mass; percentage composition and empirical and molecular formula; chemical reactions, stoichiometry and calculations based on stoichiometry.

### **UNIT 2: STRUCTURE OF ATOM**

Discovery of electron, proton and neutron; atomic number, isotopes and isobars. Thompson's model and its limitations, Rutherford's model and its limitations, 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 exclusion principle and Hund's rule, electronic configuration of atoms, stability of half filled and completely filled orbitals.

### **UNIT 3: CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES**

Significance of classification, brief history of the development of periodic table, 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, valence. Nomenclature of elements with atomic number greater than 100.

### **UNIT 4: 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.

### **UNIT 5: THERMODYNAMICS**

Concepts of system, types of systems, surroundings, work, heat, energy, extensive and intensive properties, state functions. First law of thermodynamics – internal energy and enthalpy, heat capacity and specific heat, measurement of  $\Delta U$  and  $\Delta H$ , Hess's law of constant

heat summation, enthalpy of : bond dissociation, combustion, formation, atomization, sublimation, phase transition, ionization, solution and dilution. Introduction of entropy as a state function, Second law of thermodynamics, Gibbs energy change for spontaneous and non-spontaneous process, criteria for equilibrium. Third law of thermodynamics –Brief introduction.

## **UNIT 6: 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 polybasic acids, acid strength, concept of pH., Hydrolysis of salts (elementary idea), buffer solutions, Henderson equation, solubility product, common ion effect (with illustrative examples).

## **UNIT 7 : REDOX REACTIONS AND ELECTROCHEMISTRY**

Concept of oxidation and reduction, redox reactions, oxidation number, balancing redox reactions in terms of loss and gain of electron and change in oxidation numbers , applications of redox reactions. Conductance in electrolytic solutions, specific and molar conductivity variations of conductivity with concentration, Kohlrausch’s Law, electrolysis and laws of electrolysis (elementary idea), dry cell – electrolytic cells and Galvanic cells; lead accumulator, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells. Relation between Gibbs energy change and EMF of a cell, fuel cells; corrosion.

## **UNIT 8 : SOLUTIONS**

Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, colligative properties – relative lowering of vapour pressure, Raoult’s law , elevation of B.P., depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass, Vant Hoff factor.

## **UNIT 9: CHEMICAL KINETICS**

Rate of a reaction (average and instantaneous), factors affecting rates of reaction: concentration, temperature, catalyst; order and molecularity of a reaction; rate law and specific rate constant, integrated rate equations and half life (only for zero and first order reactions); concept of collision theory (elementary idea, no mathematical treatment).Activation energy, Arrhenious equation.

### **UNIT 10: D AND F BLOCK ELEMENTS**

General introduction ,electronic configuration, occurrence and characteristics of transition metals, general trends in properties of the first row transition metals – metallic character, ionization enthalpy, oxidation states, ionic radii, colour, catalytic property, magnetic properties, interstitial compounds, alloy formation. Preparation and properties of  $K_2Cr_2O_7$  and  $KMnO_4$ . Lanthanoids – electronic configuration, oxidation states, chemical reactivity and lanthanoid contraction and its consequences. Actinoids – Electronic configuration, oxidation states and comparison with lanthenoids .

### **UNIT 11: COORDINATION COMPOUNDS**

Coordination compounds : Introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds, bonding, Werner's theory VBT,CFT; isomerism (structural and stereo)importance of coordination compounds (in qualitative analysis, extraction of metals and biological systems).

### **UNIT 12: ORGANIC CHEMISTRY – SOME BASIC PRINCIPLES AND TECHNIQUES**

General introduction, methods of purification, qualitative and quantitative analysis, 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.

### **UNIT 13: HYDROCARBONS**

Classification of Hydrocarbons. Aliphatic Hydrocarbons: Alkanes – Nomenclature, isomerism, conformations (ethane only), physical properties, chemical reactions including free radical mechanism of halogenation, combustion and pyrolysis. 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 mono-substituted benzene; carcinogenicity and toxicity.

## **UNIT 14: HALOALKANES AND HALOARENES**

Haloalkanes: Nomenclature, nature of C-X bond, physical and chemical properties, mechanism of substitution reactions. Optical rotation. Haloarenes: Nature of C-X bond, substitution reactions (directive influence of halogen for monosubstituted compounds only). Uses and environmental effects of – dichloromethane, trichloromethane, tetrachloromethane, iodoform, freons, DDT.

## **UNIT 15: 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, uses, with special reference to methanol and ethanol. Phenols : Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophilic substitution reactions, uses of phenols. Ethers : Nomenclature, methods of preparation, physical and chemical properties, uses.

## **UNIT 16: ALDEHYDES, KETONES AND CARBOXYLIC ACIDS**

Aldehydes and Ketones: Nomenclature, nature of carbonyl group, methods of preparation, physical and chemical properties, and mechanism of nucleophilic addition, reactivity of alpha hydrogen in aldehydes; uses. Carboxylic Acids: Nomenclature, acidic nature, methods of preparation, physical and chemical properties; uses.

## **UNIT 17: ORGANIC COMPOUNDS CONTAINING NITROGEN**

Amines: Nomenclature, classification, structure, methods of preparation, physical and chemical properties, uses, identification of primary secondary and tertiary amines. Cyanides and Isocyanides – will be mentioned at relevant places in context. Diazonium salts: Preparation, chemical reactions and importance in synthetic organic chemistry.

## **UNIT 18: BIOMOLECULES**

Carbohydrates – Classification (aldoses and ketoses), monosaccharide (glucose and fructose), D-L configuration, oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen): importance. Proteins - Elementary idea of a - amino acids, peptide bond, polypeptides, proteins, primary structure, secondary structure, tertiary structure and quaternary structure (qualitative idea only), denaturation of proteins; enzymes. Hormones – Elementary idea (excluding structure). Vitamins – Classification and functions. Nucleic Acids: DNA and RNA