

Chemistry

Physical Chemistry

1. **Basic principles of chemistry:-** Importance of chemistry, Nature of Matter, Properties of Matter and their measurement, Uncertainty in measurements, Laws of chemical combinations, Dalton's Atomic Theory, Atomic and Molecular Masses, Mole concept and molar masses Percentage Composition, Stoichiometry and Stoichiometric Calculations
2. **Atomic structure:-** Sub atomic Particles, Atomic models, Developments Leading to the Bohr's model of atom, Bohr's Model for hydrogen atom, towards Quantum Mechanical model of the Atom, Quantum mechanical model of Atom, Nature of electromagnetic radiation, photoelectric effect limitations of Bohr's model, Dual nature of matter, de-Broglie's relationship, Heisenberg uncertainty principle, various quantum numbers (principal, angular momentum and magnetic quantum numbers) and their significance, shapes of s, p and d - orbitals, electron spin quantum number, Rules for filling electrons in orbitals-aufbau principle, Pauli's exclusion principle and Hund's rule, electronic configuration of elements, extra stability of half-filled and completely filled orbitals.
3. **States of Matter:-** Intermolecular Forces, Thermal Energy, Intermolecular forces vs thermal interactions, The Gaseous state, The Gas laws, Ideal gas equation, Kinetic Molecular theory of Gases, Liquification of Gases, Liquid state
4. **Chemical Bonding and Molecular Structure:-** Kossel - Lewis approach to chemical bond formation, concept of ionic and covalent bonds, Ionic Bonding, Formation of ionic bonds, factors affecting the formation of ionic bonds, calculation of lattice enthalpy, Covalent Bonding, Concept of 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, concept of hybridization involving s, p and d orbitals, Resonance, Molecular Orbital Theory, LCAOs, types of molecular orbitals (bonding, antibonding), sigma and pi-bonds, molecular orbitals electronic configurations of homonuclear diatomic molecules, concept of bond order, bond length and bond energy, Elementary idea of metallic bonding, Hydrogen bonding and its applications.
5. **Basic principles and applications of spectroscopy:-** Rotational, vibrational, electronic, Raman, ESR, NMR
6. **Thermodynamics:-** Fundamental of thermodynamics, System and surroundings, extensive and intensive properties, state functions, types of processes, First law of thermodynamics, concept of work, heat internal energy and enthalpy, heat capacity, molar heat capacity, Hess's law of constant heat summation, Enthalpies of bond dissociation, combustion, formation, atomization, sublimation, phase transition, hydration, ionisation and solution. 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 equilibrium constant.
7. **Equilibrium:-** Meaning of equilibrium, concept of dynamic equilibrium. Equilibria involving physical processes: Solid - liquid, liquid - gas and solid - gas equilibria, Henry's

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- law, general characteristics of equilibrium involving physical processes. Equilibria involving chemical process: Law of chemical equilibrium, equilibrium constants (K_p and K_c) and their significance, significance of ΔG and ΔG° in chemical equilibria, factors affecting equilibrium concentration, pressure, temperature, effect of catalyst; Le Chatelier's principle. Ionic equilibrium: Weak and strong electrolytes, ionization of electrolytes, various concepts of acids and bases (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, solubility of sparingly soluble salts and solubility products, buffer solutions.
8. Redox Reactions and Electrochemistry:- Electronic concept of oxidation and reduction, redox reactions, oxidation number, rules for assigning oxidation number balancing of redox reactions. Electrolytic and metallic conduction, conductance in electrolytic solutions, specific and molar conductivities and their variation with concentration: Kohlrausch's law and its applications. Electrochemical cells - Electrolytic and Galvanic cells, different types of electrodes, electrode potentials including standard electrode potential, half-cell and cell reactions, emf of a Galvanic cell and its measurement; Nernst equation and its applications; Relationship between cell potential and Gibbs' energy change, Dry cell and lead accumulator; Fuel cells.
 9. Chemical Kinetics:- Rate of a chemical reactions, factors affecting the rate of reactions: concentration, temperature, pressure and catalyst; elementary and complex reactions, order and molecularity of reactions, rate law, constant and its units, differential and integral forms of zero and first order reactions, their characteristics and half-lives, effect of temperature on rate of reactions - Arrhenius theory, activation energy and its calculation, collision theory of bimolecular gaseous reactions (no derivation).
 10. Surface chemistry:- Adsorption - Physisorption and chemisorptions and their characteristics, factors affecting adsorption of gases on solids - Freundlich and Langmuir adsorption isotherms, adsorption from solutions, Colloidal state - distinction among true solutions, colloids and suspensions, classification of colloids - lyophilic, lyophobic; multi molecular, macromolecular and associated colloids (micelles), preparation and properties of colloids - Tyndall effect, Brownian movement, electrophoresis, dialysis, coagulation and flocculation; Emulsions and their characteristics.
 11. Solid States:- General Characteristics of solid state, Amorphous and Crystalline Solids, Classification of Crystalline Solids, Crystal Lattices and Unit Cell, Close-Packed Structures, Packing Efficiency, Calculations Involving Unit Cell Dimensions, Imperfections in Solids, Electrical Properties, Magnetic Properties.
 12. Concepts of catalysis:- Homogenous and heterogeneous catalysis.
 13. Solutions:- Types of Solutions, Expressing concentration of solutions, Solubility, Vapour pressure of liquid solutions, Ideal and Non-ideal solutions, Colligative Properties and Determination of Molar Mass, Abnormal Molar Masses

Inorganic Chemistry

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

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- d and f block elements, periodic trends in properties of elements atomic and ionic radii, ionization enthalpy, electron gain enthalpy, valence, oxidation states and chemical reactivity.
2. **General principles & process of isolation of metals:-** Modes of occurrence of elements in nature, minerals, ores; Steps involved in the extraction of metals - concentration, reduction (chemical and electrolytic methods) and refining with special reference to the extraction of Al, Cu, Zn and Fe; Thermodynamic and electrochemical principles involved in the extraction of metals.
 3. **Hydrogen:-** Position of hydrogen in periodic table, isotopes, preparation, properties and uses of hydrogen; Physical and chemical properties of water and heavy water, Structure preparation, reactions and uses of hydrogen peroxide; Hydrogen as a fuel.
 4. **S-Block elements:-** Group-1 and 2 elements introduction, electronic configuration and general trends in physical and chemical properties of elements, anomalous properties of the first element of each group, diagonal relationships. Preparation and properties of some important compounds - sodium carbonate and sodium hydroxide; Industrial uses of lime, limestone Plaster of Paris and cement; Biological significance of Na, K, Mg and Ca.
 5. **P-Block elements:-** Group 13 to Group 18 elements, Electronic configuration general trends in physical and chemical properties of elements across the periods and down the group; unique behavior of the first element in each group. Preparation, properties and uses of boron and aluminium; properties of boric acid, diboron, boron trifluoride, aluminium chloride and alums, Allotropes of carbon, catenation; Structure & properties of silicates and zeolites. Properties and uses of nitrogen and phosphorus; Allotropic forms, structure and uses of ammonia, nitric acid, and PCl_3 , PCl_5 ; Structures of oxides of phosphorus. Preparation, properties, structures and uses of ozone; Allotropic forms of sulphur, sulphuric acid and structures of oxoacids of sulphur.
 6. **d-&f Block elements:-** Position in periodic table, electronic configurations of d-block elements, general properties of the transition elements (d-Block), some important compounds of transition elements, the lanthanoids, the actinoids, some application of d^3 and f-Block elements. Preparation, properties and uses of $K_2Cr_2O_7$ and $KMnO_4$.
 7. **Co-ordination compounds & Organometallic compounds:-** Introduction to co-ordination compounds, Werner's theory; ligands, co-ordination number, denticity, chelation; IUPAC nomenclature of mononuclear co-ordination compounds, isomerism; Bonding - Valence bond approach and basic ideas of Crystal field theory, colour and magnetic properties; Importance of co-ordination compounds (in qualitative analysis, extraction of metals and in biological systems), Organometallic compounds-synthesis, bonding and structure, and reactivity. Organometallics in homogenous catalysis. Cages and metal clusters.
 8. **Environmental Chemistry:-** Environmental pollution - Atmospheric, water and soil, Atmospheric pollution-Tropospheric and Stratospheric Tropospheric pollutants- Gaseous pollutants: Oxides of carbon, nitrogen and sulphur, hydrocarbons; their sources, harmful effects and prevention; Green house effect and Global warming; Acid rain; Particulate pollutants: Smoke, dust, smog, fumes, mist; their sources, harmful effects and

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

9. Nuclear Chemistry:- Nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.
10. Analytical chemistry:- Separation techniques, Spectroscopic electro and thermoanalytical methods.
11. Bioinorganic Chemistry:- Photosystems, porphyrines, metalloenzymes, oxygen transport, electron transfer reactions, nitrogen fixation.
12. Physical characterization of inorganic compounds by IR, Raman, NMR, EPR, Mossbauer, UV-, NQR, MS, electron spectroscopy and microscopic techniques.

Organic Chemistry

1. Purification & Characterisation of organic compounds:- Purification - Crystallization, sublimation, distillation, differential extraction and chromatography - principles and their applications. Qualitative analysis - Detection of nitrogen, sulphur, phosphorus and halogens. Quantitative analysis- Estimation of carbon, hydrogen, nitrogen, halogens, sulphur, phosphorus. Calculations of empirical formulae and molecular formulae; Numerical problems in organic quantitative analysis.
2. Some basic principles of organic chemistry:- Tetravalency of carbon - Shapes of simple molecules - hybridization (s and p); Classification of organic compounds based on functional groups :- C = C -, -Carbon Carbon triple bond and those containing halogens, oxygen, nitrogen and sulphur, Homologous series; Isomerism -structural and stereoisomerism. Nomenclature (Trivial and IUPAC) Covalent bond - 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.
3. Chemistry of Hydrocarbon:- Classification, Isomers in IUPAC nomenclature, general methods of preparation, properties and reactions. Alkanes - Conformations : Sawhorse and Newman projections (of ethane); Mechanism of halogenations of alkanes. Alkenes - Geometrical isomerism; Mechanism of electrophilic addition: addition of hydrogen halogens, water hydrogen halides (Markownikoff's and peroxide effect); Ozonolysis and polymerization. Alkynes - Acidic character, Addition of hydrogen, halogens, water and hydrogen halides; Polymerization. Aromatic hydrocarbons - Nomenclature, benzene - structure and aromaticity; Mechanism of electrophilic substitution: halogenations, nitration, Friedel - Craft's alkylation and acylation, directive influence of functional group in mono - substituted benzene.
4. Organic compounds - containing Halogens:- General methods of preparation, properties and reactions; Nature of C -X bond; Mechanisms of substitution reactions; Uses; Environmental effects of chloroform & iodoform.

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5. **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 : halogenations, nitration and sulphonation, Reimer – Tiemann reaction. Ethers : Structure. Aldehyde and ketones : Nature of carbonyl group; Nucleophilic addition to $>C=O$ group, relative reactivities of aldehydes and ketones: Important reactions such as – Nucleophilic addition reactions (addition of HCN, NH_3 and its derivatives), Grignard reagent; oxidation; reduction (Wolff Kishner and Clemmensen); acidity of hydrogen, aldol condensation, Cannizzaro reaction, Halbform reaction; Chemical tests to distinguish between aldehydes and Ketones. Methods of preparation properties, reactions and uses of carboxylic acids, acidic strength and factors affecting it.
6. **Organic compounds – containing Nitrogen:-** General methods of preparation; properties, reactions and uses. Amines: Nomenclature, classification, structure, basic character and identification of primary, secondary and tertiary amines and their basic character. Diazonium salts: Importance in synthetic organic chemistry.
7. **Polymers:-** General introduction and classification of polymers, general methods of polymerization – addition and condensation, copolymerization; Natural and synthetic rubber and vulcanization; some important polymers with emphasis on their monomers and uses – polythene, nylon, polyester and bakelite.
8. **Biomolecules:-**General introduction and importance of biomolecules. Carbohydrates- Classification : aldoses and ketoses; monosaccharides and constituent monosaccharides of oligosaccharides, starch. Proteins – primary, secondary, tertiary and quaternary structure (qualitative ideas only), denaturation of proteins, enzymes. Vitamins – Classification and functions. Nucleic Acids – Chemical constitution of DNA and RNA. Biological functions of nucleic acids.
9. **Chemistry in Everyday Life:-** Chemical in medicines – Analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamins – their meaning and common examples. Chemical in food – Preservatives, artificial sweetening agents – common examples. Cleansing agents – Soaps and detergents, cleansing action.
10. **Common reagents (organic, inorganic and organometallic) in organic synthesis.**
11. **Selective organic transformations – chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity. Protecting groups.**
12. **Physical characterization of organic compounds by IR, UV-, MS and NMR.**
13. **Principles related to Practical Chemistry.**

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Analysis: Elementary set theory, Sets:

Sets and their representations. Empty set, Finite & Infinite sets, Equal sets. Subsets, Subsets of the set of real numbers especially intervals (with notations). Power set. Universal set. Venn diagrams. Union and Intersection of sets. Difference of sets. Complement of a set, Properties of complement sets.

Finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum.

Sequence and series:

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

Binomial Theorem:

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

Continuity and Differentiability:

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

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

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

Applications of Derivatives:

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

Limits and Derivatives:

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

Integrals: Integration as inverse process of differentiation. Integration of a variety of functions by

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substitution, by partial fractions and by parts. Definite integrals as a limit of a sum. Fundamental Theorem of Calculus, Basic properties of definite integrals and evaluation of definite integrals.

Applications of the Integrals:

Applications in finding the area under simple curves, especially lines, areas of circles/parabolas/ellipses, area between the two above said curves. Riemann sums and Riemann Integral, Improper Integrals.

Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral. Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems. Metric spaces, compactness, connectedness. Normed linear Spaces. Spaces of continuous functions as examples.

Linear Algebra:

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

Linear Inequalities:

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

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

Matrices & Determinant:

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

Determinant of a square matrix (up to 3x3 matrices), properties of determinants, minors, cofactors and applications of determinants in finding the area of a triangle.

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

Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification of quadratic forms

Straight Lines:

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

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through the point of intersection of two lines. Distance of a point from a line.

Conic Sections:

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

Introduction to Three-dimensional Geometry:

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

Three-dimensional Geometry:

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

UNIT - 2

Complex Numbers and Quadratic Equations:

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

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

Trigonometric Functions:

Positive and negative angles. Measuring angles in radians and in degrees and conversion from one measure to another. Definition of trigonometric functions with the help of unit circle. Truth of the identity $\sin^2 x + \cos^2 x = 1$, for all x . Signs of trigonometric functions and sketch of their graphs. Expressing $\sin(x \pm y)$ and $\cos(x \pm y)$ in terms of $\sin x$, $\sin y$, $\cos x$ & $\cos y$.

Identities related to $\sin 2x$, $\cos 2x$, $\tan 2x$, $\sin 3x$, $\cos 3x$ and $\tan 3x$. General solution of trigonometric equations of the type $\sin \theta = \sin \alpha$, $\cos \theta = \cos \alpha$ and $\tan \theta = \tan \alpha$.

Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem. Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations.

Algebra:

Permutations & Combinations:

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

Fundamental theorem of arithmetic, divisibility in \mathbb{Z} , congruences, Chinese Remainder Theorem, Euler's ϕ -function, primitive roots.

Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation

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Groups, Cayley's theorem, class equations, Sylow theorems.

Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain.

Polynomial rings and irreducibility criteria. Fields, finite fields, field extensions, Galois Theory. Dense sets, subspace and product topology, separation axioms, connectedness and compactness.

UNIT - 3

Ordinary Differential Equations (ODEs):

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, homogeneous differential equations of first order and first degree. Solutions of linear differential equation of the type:

$\frac{dy}{dx} + py = Q$ where P and Q are functions of x or constant.

$\frac{dx}{dy} + px = Q$ where P and Q are functions of y or constant

Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs.

General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function.

Partial Differential Equations (PDEs):

Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs.

Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

Numerical Analysis:

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

Calculus of Variations:

Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations.

Linear Integral Equations:

Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and eigenfunctions, resolvent kernel.

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Classical Mechanics:

Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle and principle of least action, Two-dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

UNIT - 4

Descriptive statistics, exploratory data analysis

Mathematical Reasoning:

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

Statistics:

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

Probability:

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

Probability of an event, probability of 'not', 'and' & 'or' events. Multiplication theorem on probability. Conditional probability, independent events, total probability, Baye's theorem, Random variable and its probability distribution, mean and variance of haphazard variable. Repeated independent (Bernoulli) trials and Binomial distribution. Sample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Probability inequalities (Tchebyshef, Markov, Jensen). Modes of convergence, weak and strong laws of large numbers, Central Limit theorems.

Markov chains with finite and countable state space, classification of states, limiting behaviour of n-step transition probabilities, stationary distribution, Poisson and birth-and-death processes.

Standard discrete and continuous univariate distributions. sampling distributions, standard errors and asymptotic distributions, distribution of order statistics and range.

Methods of estimation, properties of estimators, confidence intervals. Tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests. Analysis of discrete data and chi-square test of goodness of fit. Large sample tests. Simple non-parametric tests for one and two sample problems, rank correlation and test for independence. Elementary Bayesian inference.

Gauss-Markov models, estimability of parameters, best linear unbiased estimators, confidence intervals, tests for linear hypotheses. Analysis of variance and covariance. Fixed, random and mixed effects models. Simple and multiple linear regression. Elementary regression diagnostics. Logistic regression. Multivariate normal distribution, Wishart distribution and their properties. Distribution of quadratic forms. Inference for parameters, partial and multiple correlation coefficients and related tests. Data reduction



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Techniques: Principle component analysis, Discriminant analysis, Cluster analysis, Canonical correlation.

Simple random sampling, stratified sampling and systematic sampling. Probability proportional to size sampling. Ratio and regression methods.

Completely randomized designs, randomized block designs and Latin-square designs. Connectedness and orthogonality of block designs, BIBD. 2^k factorial experiments: confounding and construction.

Series and parallel systems, hazard function and failure rates, censoring and life testing.

Linear Programming Problem:

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

Simplex methods, duality. Elementary queuing and inventory models. Steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1.

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