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BIOSCIENCES

Diversity of cell: Cell structure & organelles functions, Cell cycle, Cytoskeleton, Cell Communication.

Biomolecules: Amino acids, proteins, carbohydrates, lipids and enzymes.

Nucleic acid structure and function: Structure of DNA, RNA, DNA replication, RNA synthesis, Protein synthesis and processing, Control of gene expression at transcription and translation level.

Genomics: Molecular mapping of genome and Recombinant DNA Technology.

Immunology: Immune system and applications.

Microbiology: Microorganisms, growth curve, microbial products such as drugs, organic acids, enzymes and fermentation technology.

Plant biotechnology: Plant growth regulators, plant tissue culture and different culture techniques, GM crops.

Environmental science: Ecosystem, pollution and different aspects of environment, green revolution, biodiversity and its conservation. Animal physiology: Tissue, organ and organ system of human.

Biotechniques: Chromatography, Electrophoresis, Spectroscopy and PCR.

Bioinformatics: Databases, Sequence alignment; Phylogenetics; Homology modelling; Genomics, proteomics and metabolomics.

CHEMISTRY

Organic Chemistry Carbonium ions,carbanions, carbenes, nitrenes, radicals and arynes, Reactive intermediates, Nucleophilic,Electrophilic, Radical substitution, Addition and Elimination reactions. Barton,Baeyer-villigier, Birch, Chichibabin, Clemmensen Diels-alder, Friedel crafts, Hoffmann,Hofmann-Loffler-Freytag, Hydroboration, Lossen, Mannich, Michael addition,Meerwein-Ponndorf-Verley, Perkin, Grignard, Reimer-Tiemann, Reformatsky, Storkenamine, Wittig, Wolff-Kishner. Oppenaur oxidations, Robinson annulations, Routine functional group transformations and inter-conversions of simple functionalities, Aldol,Clasien, Stobbe and Dieckmann, Schmidt, Condensations, Beckmann and Fries, Favorski,Curtius Rearrangements. Stereochemistry and Conformational Analysis: Pericyclic Reactions, Photochemistry, Dyes.

Physical Chemistry: Basic principles and applications of quantum mechanics, Variational and perturbational methods. Basics of atomic structure, electronic configuration, shape of orbitals, hydrogen

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atom spectra. Theoretical treatment of atomic structures and chemical bonding. Chemical applications of group theory. Basic principles and application of spectroscopy – rotational, vibrational, electronic, Raman, ESR, NMR, Chemical thermodynamics, Phase equilibria, Statistical thermodynamics, Chemical equilibria, Electrochemistry, Chemical kinetics, Polymer chemistry, Solid State Chemistry, Colloids and surface phenomena, non-ideal systems

Inorganic Chemistry: Chemical periodicity. Structure and bonding, Concepts of acids and bases, Chemistry of the main group elements and their compounds. Allotropy, synthesis, bonding and structure, Chemistry of transition elements and coordination compounds, Inner transition elements, Organometallic compounds, Cages and metal clusters, Analytical chemistry separation techniques. Spectroscopic electro- and thermo-analytical methods, Bioinorganic chemistry, Physical characterization of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-, NQR, MS, electron spectroscopy and microscopic techniques. Nuclear chemistry.

COMPUTER APPLICATIONS

Discrete Mathematics: Sets Operations & Relations, Propositional and Predicate Logic, Groups, Subgroups, Semi Groups, Product and Quotients of Algebraic Structures, Boolean Functions & their Representations.

Graph Theory: Simple Graph, Multigraph, Weighted Graph, Paths and Circuits, Shortest Paths in Weighted Graphs, Eulerian Paths and Circuits, Hamiltonian Paths and Circuits.

Computer Basics & Algorithms: Data Representation, Computer Organization and Design, Memory, Input/Output, Operating System Structure, Operations and Services; System, Operating System Design and Implementation, Computer Algorithm, Data Structure & their Design Techniques, Algorithm Performance Evaluation, Programming Approaches and their Basic Elements, Structure Oriented Programming & Object-Oriented Programming Concepts, Web Programming.

Database & their Advancement: Architecture & Modeling, SQL, Relational Database, Data Mining & Knowledge Extraction, Big Data Analytics.

Software Engineering: Software Process and Feasibility Study, Software Requirements, Software Design and Implementation, Software Testing, Quality Assurance and Project Estimation.

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Computer Networks & Communications: Data Communication, Network Topologies, Models and their Functionality, Network Security, Mobile Communications.

Advancement in Computer Science/Applications: Artificial Intelligence and Neural Networks, Fuzzy Logics, Internet of Things, Cloud Computing, Block Chain, Data Science.

ENVIRONMENTAL SCIENCE

Fundamentals of Environmental Science: Definition, Principles, Importance and Scope of Environmental Science. Environmental education and awareness, Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Laws of thermodynamics, heat transfer processes, mass and energy transfer across various interfaces, material balance. Interaction between Earth, Man and Environment. Biogeographic provinces of the world and agro-climatic zones of India. Concept of sustainable development and sustainability.

Environmental Monitoring and Analysis: Methods and principles of environmental monitoring, sampling methods of water, air and soil sampling, Determination of COD, BOD, DO and metal content in water samples. Determination of Air Quality Index and air quality parameters. Principles of analytical methods: Titrimetry, Gravimetry, Bomb Calorimetry, Chromatography (Paper Chromatography, TLC, GC and HPLC), Flame photometry, Spectrophotometry (UV-VIS, AAS, ICP-AES, ICP-MS),

Ecosystem and Ecological Succession: Ecosystem Concept, definition, Structure and functions: Structures - Biotic and Abiotic components. Functions - Energy flow in ecosystems, energy flow models, food chains and food webs. Biogeochemical cycles, Ecological succession; primary and secondary, Concept of ecotone, edge effects, ecological habitats and niche. Ecosystem stability and factors affecting stability. Ecosystem services. Basis of Ecosystem classification. Types of Ecosystem: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), Oceanic.

Biodiversity and its conservation: Definition, types and level of biodiversity, values of biodiversity, threats to biodiversity; Concept and basis of identification of 'Biodiversity Hotspots'; hotspots in India. Measures of biodiversity. Strategies for biodiversity conservation: in situ and ex situ conservation. National parks, Sanctuaries, Protected areas and Sacred groves in India. Concepts

of gene pool, biopiracy and bio-prospecting. Concept of restoration ecology. Extinct, Rare, Endangered and Threatened flora and fauna of India.

Energy and Environment: Non-Renewable and Renewable Energy resources and their environmental issues, Detrimental impact of burning of fossil fuels: coal, petroleum and natural gas. Renewable energy sources; opportunities and challenges of solar energy, hydro-power, tidal energy, ocean thermal energy conversion, wind power, geothermal energy, solar energy (solar collectors, Nuclear energy - fission and fusion, Nuclear fuels, Nuclear reactor – principles and types. Bioenergy: methods to produce energy from biomass.

Environmental Pollution: Air Pollution: Sources and types of Pollutants - Natural and anthropogenic sources, primary and secondary pollutants. Criteria air pollutants. Sampling and monitoring of air pollutants (gaseous and particulates). Indian National Ambient Air Quality Standards. Impact of air pollutants on human health, plants and materials. Acid rain. Dispersion of air pollutants. Control devices: settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator, adsorption, absorption, condensation and combustion including catalytic combustion. Indoor air pollution, Vehicular emissions and Urban air quality. **Water Pollution:** Types and sources of water pollution. Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN. Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant. **Soil pollution** causes and control measures. **Noise Pollution:** Sources, weighting networks, measurement of noise indices. Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements. Impact of noise and vibrations on human health, Solid waste management, Nuclear hazardous.

Environmental Policies and Legislation: Global Environmental Issues; climate change, global warming, ozone layer depletion, acid rain, Aims and objectives of Environmental Impact Assessment (EIA). EIA Guidelines. Overview of Environmental Laws in India: Constitutional provisions in India (Article 48A and 51A). Wildlife Protection Act, 1972, Forest Conservation Act,

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1980, Biological Diversity Act, 2002, Water (Prevention and Control of Pollution) Act, 1974, Air (Prevention and Control of Pollution) Act 1981, Environmental (Protection) Act, 1986, The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997.

Human Community and the Environment: Human population growth, human health and welfare, urbanization, Resettlement and rehabilitation, case studies, Disaster management, Environmental ethics, Environmental communication and public awareness, tribal populations and rights, and human wildlife conflicts in Indian context, Environmental ethics, Environmental movement.

MATHEMATICS

Analysis: Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem.

Linear Algebra: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis

Complex Analysis: Algebra of complex numbers, the complex plane, polynomials, Power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula,

Ordinary Differential Equations (ODEs): 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.

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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, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

Special Functions & Integral Transform: Gauss hypergeometric function and its properties, Integral representation, Linear and quadratic transformation formulas, Contiguous function relations, Integral representation, Legendre functions Pn(x) and Qn(x) and their properties. Bessel functions Jn(x). Laplace transform, Fourier Transforms

Fluid Dynamics: Governing equations of fluid motion; streamline; velocity potential, path line, equation of continuity, Motion in two dimensions; stream function; complex potential; source; sink and doublet; image circle theorem, Viscous fluid, Stokes-Navier equations

Discrete Mathematics: Set Theory, Types of relations on sets and their properties, Relational matrix and the graph of a relation, Partitions, Equivalence relations, Poset, Hasse diagram. Definitions & Classification of functions, Characteristic function of a set, Hashing functions, Recursive functions, Permutation functions. Discrete numeric function, Basic counting principles, Generating functions, Recurrence relations, Inclusion and exclusion principle

Linear Programming Problem: The Linear programming problem. Mathematical Formulation of thes Problem, Types of solutions, Linear programming in matrix notation. Some Exceptional Cases, General Linear Programming Problem Slack and Surplus Variables, Theory and application of the simplex method of solution of a linear programming problem, Charne's M-technique, The two-phase method, Duality, Transportation & Assignment Problems.

STATISTICS

Measures of central tendency and Dispersion: Raw and Central Moments, Skewness and Kurtosis. Analysis of Categorical data Consistency of categorical data, Independence and association of attributes

Probability: Probability Distribution: Binomial, Poisson and Normal, Exponential. Sampling

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distributions: Student - t distributions, F- distribution, Fisher's z – distribution and Chi-square distribution. Inter relations. Simple tests based on t, F, chi square and normal variate z.

Sampling: Simple random sampling, Stratified Sampling, systematic sampling, PPS sampling, Multistage sampling and Double sampling.

Use of supplementary information: Ratio, Regression, Difference and Product estimation. Inference: properties of good estimators, Neyman - Pearson lemma (with emphasis on the motivation of theory of testing of hypothesis) Uniformly most powerful test and sufficient statistics, power function.one and two sided tests. Likelihood ratio test and its applications, asymptotic distribution of LR statistic and asymptotic power of LR tests. An optimum property of sufficient statistics. Elementary ideas of complete statistics, Completeness of sufficient statistics. Sequential analysis. Concept of ASN and OC functions. Wald's sequential probability ratio test and its OC and ASN functions.

Design of Experiment: CRD, RBD, LSD, Factorial experiments: 22 -experiment, 23 -experiment and 2n -experiment in 2k blocks per replicate. Confounding, Split-plot design. Incomplete Block Design, Balanced and Partially balanced incomplete block design, construction and analysis with and without recovery of intrablock information. Orthogonal Latin squares.

Correlation and Regression: Simple, rank, Partial, Multiple correlation and regression, Testing of hypothesis, simple against simple.

Time Series: Methods of measuring, linear trend, seasonal variations, Vital Statistics: Measures of fertility and Mortality.

PHYSICS

Mathematical Methods of Physics: Eigenvalues and eigenvectors, linear ordinary differential equations, Special functions. Fourier series, Transforms, Elements of complex analysis, Elementary probability theory, random variables, Distributions, Green's function, Partial differential equations, Elements of computational techniques, Tensors.

Classical Mechanics: Newton's laws, Central force motions, two body Collisions - scattering in lab and C.m. frames, Rigid body dynamics, Non-inertial frames and pseudo forces, Lagrangian and Hamiltonian formalism, small oscillations, normal modes, Special theory of relativity, Lorentz transformations, relativistic kinematics.

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Electromagnetic Theory: Laplace and Poisson equations, boundary value problems, Maxwell's equations in free space and linear isotropic media, Scalar/ vector potentials, gauge invariance, Dispersion relations in plasma, Lorentz invariance of Maxwell's equations, Transmission lines and wave guides, Radiation- from moving charges and dipoles, Retarded potentials.

Quantum Mechanics: Schrödinger's equation and its applications for simple problems, Heisenberg uncertainty principle, Dirac notation, Motion in a central potential, angular momentum algebra, Hydrogen atom, Approximation methods, Fermi's golden rule, Pauli exclusion principle, Elementary theory of scattering, Klein-Gordon and Dirac equations.

Thermodynamic and Statistical Physics: Laws of thermodynamics, Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria, micro- and macro-states, Micro-canonical, canonical and grand-canonical ensembles and partition functions, Free energy and its connection with thermodynamic quantities, Classical / quantum statistics, Bose and Fermi gases, Diamagnetism, Para magnetism, and ferromagnetism, Bose-Einstein condensation, Diffusion equation, Nonequilibrium processes.

Electronics and Experimental Methods: Semiconductor devices, frequency dependence and application, Opto-electronic devices, Operational amplifiers and their applications, Digital techniques and applications, Microprocessor and microcontroller basics.

Atomic & Molecular Physics: Spectrum of He and alkali atoms, LS & JJ couplings, Zeeman, Paschen-Bach & Stark effects, E.S.R. and N.M.R., chemical shift, Frank-Condon principle, Born-Oppenheimer approximation, Diatomic molecules, spectra, Lasers.

Condensed Matter Physics: Bravais lattices, Reciprocal lattice, Diffraction and the structure factor, bonding of solids, Elastic properties, phonons, lattice specific heat, Free electron theory and electronic specific heat, Response and relaxation phenomena, Hall effect, Periodic potential, Type-I and type-II superconductors, Josephson junctions, Super fluidity, Defects and dislocations.

Nuclear and Particle Physics: Binding energy, semi empirical mass formula, liquid drop model, Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces, Deuteron problem, Shell structure, single-particle shell model, Rotational spectra, Fission and fusion, Classification of fundamental forces, Quark model, C, P, and T invariance, Weak interactions.