CONTENTS

1. MATHEMATICS (PAPER-I)
[Paper Code: MTM-I, Full Marks: 100, Time: 3 hours]

Group – A : Classical Algebra.

Zeroes of a polynomial, transformation of equations, solution of a cubic and a biquadratic equation, Determinant and matrices, minors and cofactors, rank of a matrix, solution of a system of linear equations, Jacobi's theorem. Hermitan and skew hermitian matrices.

Inequalities, A.M>G.M>H.M, mith power theorem, Cauchy – Schwartz theorem, Weierstrass' theorem.

De Moivre's theorem and its application, exponential sine, Cosine and logarithm of a complex number, hyperbolic functions, Gregory's series. Boolean algebra, definition and examples, Boolean functions, application to switching circuits.

Group – B : Abstract and Linear Algebra.

Groups, Subgroups, cyclic groups, permutation groups, cosets, Lagrange's theorem, normal subgroups, quotient groups, homomorphism and isomorphism of groups, Kernel of group homomorphism.

Rings, integral domain, skew field, field, sub rings, subfields.

Linear spaces and subspaces, basis, Linear transformation, rank and nullity theorem, Existence theorem for basis, replacement theorem, extension theorem.

Inner product space, Gram-Schmidt orthogonalisation process, eigen values, eigen vectors, Cayley-Hamilton theorem, real quadratic forms, index, rank and signature.

Group – C : Co-ordinate Geometry of two and three dimensions; Vectors and tensors.

Pair of straight lines, polar equation of a circle and of a conic, tangents and normals, chord of contact and diameters, pole and polar, general equation of second degree in two variables and reduction into canonical form.

Rectangular Cartesian Co-ordinates in space, direction ratio, direction cosine of a vector, projection of a vector on a line, equation of a plane in different forms, condition of perpendicularity and parallelism of planes, straight lines in space, their equations in different forms, condition of perpendicularity and parallelism of two straight lines, bisectors of the angle between two straight lines, a pair of skew straight lines, shortest distance of two straight lines, bisection of the angle between two planes, intersection of three planes.

Sphere, Cone and Cylinder.

Scaler and vector products of two and three vectors, their application to geometry and mechanics.

Differentiation and integration of vectors, directional derivatives, gradient, curl, divergents of vectors, Gauss, Green, Stokes's theorem and their applications.

Contravariant, Covariant and mixed tensors, Kroneeker's delta, algebra of tensors, Symmetric and skew symmetric tensors, outer and inner products, quotient law, reciprocal tensors, Riemannian space, christoffel's symbols and their laws of transformations.

Group – D : Optimization.

Linear and Convex combination of vectors, Convex set, hyperplane, hyperplane is a convex set, basic solution, basic feasible solution, set of basic feasible solutions is a convex set, extreme points, reduction of a basic solution to basic feasible solution, slack, surplus and artificial variables, standard and canonical form of L.P.P., solution of an L.P.P. by simplex method, M-Method, two-phase method, dual of an L.P.P., to find primal solution of L.P.P. by using dual principle, solution of T.P., A.P., travelling salesman problem.

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2. MATHEMATICS (PAPER-II)
[*Paper Code: MTM-II, Full Marks: 100, Time: 3 hours*]

Group – A : Mathematical Analysis-I

Continuity and differentiability of a function, successive differentiatim, Leibnitz's theorem, Rolle's theorem, Lagrange's and Cauchy's mean value theorems, generalized mean value theorems, expansion of functions like ax, ex, sin x, Cosx, Log(1+x), (1+x)m etc., indeterminate forms, L.Hospital's theorem, maximum and minimum of functions of single variable, limit and continuity of a function of two and three variables.

Partial derivatives, Euler's theorem on homogeneous functions, maximum and minimum of a function of two and three variables, Lagrange's method of multipliers.

Tangent and normal, asymptotes, curvature, envelopes, double points, uniform continuity of function, Convergence and uniform convergence of sequence and series, Abel, Dirichlet's and Weierstrass tests.

Indefinite and definite integrals, improper integrals and their convergence, Eulerian integrals, Riemann's theory of integration, elementary properties of function in relation to Riemann integral. Fundamental theorem of integral calculus, Primitives, first and second mean value theorem of integrals calculus.

Power series, radius of convergence, Fourier series, Convergence of Fourier Series, double and triple integrals, differentiation under the sign of integration.

Group – B : Mathematical Analysis-II

Definition and example of metric space, bounded metric, neighbourhood, limit points, equivalent metric spaces, continuous function, uniform continuity, isometry and homomorphism, subspace of a metric space,

Cauchy sequence, completeness of spaces, connected and separable spaces, finite intersection property, covering, Sub-covering, compactness, Heine-Bord theorem, compact spaces, compact sets.

Function of a complex variable, continuity and differentiability of complex functions, analytic function, cauchy-Riemann equations, Harmonic functions, orthogonal functions.

Second order differential equation with variable coefficient reducible to known form, wranskian, normal form of equation of the second order, simultaneous differential equations with constant coefficients, eigen value problems, total and portial differential equation, solution of differential equation of the form-

Pdx+Qdy+Rdz =0

Dx/p=dy/Q=dz/R

And Pp+Qq=Rr.

Laplace and Fourier transforms and their inverses, application of Laplace and Fourier transforms.

Group – C : Mechanics

Reduction of a system of Coplanar forces, Principle of virtual work, Common Catenary and Catenary of uniform strength, Forces in three dimensions, Poinsot's central axis and its equation, wrenches.

Simple harmonic motion, tangential and normal acceleratim, velocity and acceleratim along radial and transverse direction, motion is a resisting medium, motion of a partide under central forces, differential equations of central orbits, kepler's law of planetary motion, artificial satellite, escape velocity, geocentric satellite.

D' Alembert's Principle, motion of a rigid body about an axis, expression for Kinetic energy and moment of momentum of a rigid body, compound pendulum.

Group – D : Probability, Statistics and numerical analysis.

Classical and axiomatic definitions of probability, probability distribution, mathematical expectation, mean, variance, moments. Skewness, Kutosis.

Moment generating function, Characeristic function, two dimensional expectation, Correlation and regression, method of least square, x^2, t, F distributions, chebychev's inequality, convergence in probability, law of large number, approximation of binomial to poisson and normal distributions, Different types of sampling, sampling distribution of a statistics, test of significance, method of maximum likelihood.

Interpolation – Newton forward and backward interpolation, Lagrange's interpolation, inverse interpolation, divided difference, Newton's general interpolation formula.

Newton-Cote's integral formula, trapezoidal, simpson's, one-third formula, Weddle rule, Numerical solution of algebrain and transeendental equation by bisection, regula falsi, iteration, Newton-Raphson methods.

Numerical solution of a system of linear equation by Gauss elimination and Gauss – Jordan methods.

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3. PHYSICS (PAPER-I)

[Paper Code: PHS-I, Full Marks: 100, Time: 3 hours]

Group A: MATHEMATICAL METHODS, MECHANICS & RELATIVITY

Mathematical Methods: Scalar and Vectors: Scalar and vector fields, Differentiation of vectors, Gradient, Divergence and Curl– their meanings and applications. Vector integrations-Line, Surface and Volume integrations, Statement of Gauss' Divergence theorem, Stoke's theorem, Green's theorem and their applications to simple problems.

Matrices: Transpose of a matrix, symmetric & skew-symmetric matrices, adjoint of a matrix, matrix inversion, trace of a matrix, Hermitian, Orthogonal and Unitary matrices, eigen value and eigen vectors of a matrix, diagonalization of a matrix.

Partial Differential Equation: Laplace's equation and wave equation and their solutions in Cartesian, plane polar coordinates by the method of separation of variables.

Mechanics: Plane Curvilinear Motion: Velocity and acceleration of a particle in plane polar coordinate system (radial and transverse components of velocity and acceleration), tangential and normal components of velocity and acceleration.

Central force and central orbit, conservative force, differential equation of motion of a particle moving under central force in plane polar coordinate system.

Areal velocity, Kepler's laws of planetary motion, satellites, escape velocity, geostationary satellites and parking orbits.

Relativity: Concept of space-time according to Newtonian mechanics, Galilean transformation and invariance, inertial and non inertial frames of reference.

Michelson-Morley experiment– its difficulties. Postulate of special theory of relativity, simple derivation of Lorentz transformation formula, length contraction, time dilation, addition of velocities (velocities along same line), variation of mass with velocity, Equivalence of mass and energy.

Group B: GENERAL PROPERTIES OF MATTER, WAVES & VIBRATIONS and THERMODYNAMICS

Gravitation and Elasticity
Gravitational potential and intensity for spherical shell, Kater's pendulum. Elastic constants, moduli and their interrelations, bending moment, depression at the free end of light cantilever, depression of a light beam supported at the two ends and loaded at the middle, torsion of a cylinder, torsional oscillations.
Viscosity and Surface Tension

Fluid dynamics: Streamline and turbulent motion, equation of continuity in differential form. Bernoulli's theorem, applications of Bernoulli's theorem to venturimeter and pitot tube. Torricelli's theorem.

Viscosity and Newton's law. Critical velocity and Reynold's number, effect of temperature on viscosity, Poiseulli's equation for the flow of an incompressible fluid. Statement of Stoke's law and terminal velocity.

Surface tension: surface energy molecular theory of surface tension, factors affecting surface tension, angle of contact, explanation of elevation and depression of a liquid in a capillary tube with calculation of capillary rise, Jurin's law, excess pressure in liquid drop and bubble.

Waves and Vibrations

Differential equation of SHM and its solution, damped forced vibrations, their differential equations and solutions, resonance and sharpness of resonance.

Differential equation of plane progressive wave in one dimension and its solution, energy of waves, pressure distribution in waves.

Interference of waves, stationary waves, intensity of sound, bel and decibel.

Thermodynamics : Isothermal, adiabatic, isobaric and isochoric processes, work done in isothermal and adiabatic processes, indicator diagram, cyclic process, reversible and irreversible process.

Second law of Thermodynamics, Carnot's cycle and its efficiency, Carnot's theorem, thermodynamic scale of temperature. Entropy: its physical significance, change of entropy in reversible and irreversible processes.

Group C: ELECTROSTATICS, ELECTRO-MAGNETOSTATICS and ELECTROMAGNETIC INDUCTION

Electrostatics

Gauss's theorem in electrostatics and its application; Coulomb's theorem, mechanical force on a charged surface, energy per unit volume in a electrostatic field.

Capacitance of spherical and cylindrical capacitors, energy of charged capacitor, loss of energy due to sharing of charges.

Electric dipole, dipole moment, intensity at any point due to short dipole, torque on a dipole in an electric field and work done in rotating electric dipole placed in a uniform magnetic field (or potential energy of an electric dipole placed in a uniform electric field), dipole-dipole interaction, dielectric medium, polarization and susceptibility.

Electro-magnetostatics

Biot-Savart's law, Ampere's circuital law, magnetic field due to straight current carrying conductor, circular current carrying conductor and solenoid.

Magnetic field due to small current loop – concept of magnetic dipole and magnetic dipole moment; Lorentz force; force on current carrying conductor placed in magnetic field, force between two long parallel current carrying conductors.

Magnetic substances: Permeability, intensity of magnetization, susceptibility and their relations. Cycle of magnetization, Hysteresis, calculation of hysteresis loss of energy.

Electromagnetic Induction ,Self and mutual inductance, self inductance of a circular coil and solenoid, mutual inductance between two circular coils and between two coaxial solenoids. Eddy current and its explanation.

Growth and decay of current in L-R circuit, charging and discharging of condenser in C-R circuit, time constant,

Group D : OPTICS, LASER & FIBRE OPTICS

Optics: Fermat's principles, reflection and refraction in plane surfaces by Fermat's principle and vice versa.

Combination of thin lenses, equivalent lens, chromatic and spherical aberration. Wave nature of light, Huygen's principle, explanation of reflection and refraction of light on the basis of wave theory.

Interference – Young's experiment, Fresnel biprism, interference by Lloyd mirror, interference in thin films including wedge shaped film. Newton's ring– theory of its formation.

Diffraction (Fresnel class): half period zone, explanation of rectilinear propagation of light.

Diffraction (Fraunhoffer class): diffraction pattern of single slit, double slit and plane transmission grating.

Polarization of light by reflection, double refraction, Nicol prism and polaroids, optical activity

Laser and Fibre optics.

Laser: Population inversion, Einstein's A & B coefficients; 3-level systems; Ruby Laser, Helium-Neon Laser and principle of semiconductor lasers.

Optical fibre: Core and cladding, total internal reflection; optical fibre as waveguide; step index and graded index fibre, energy loss, band width and channel capacity- a typical system, attenuation and dispersion, splicing and couplers, fibre sensor.

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4. <u>PHYSICS (PAPER-II)</u>

[Paper Code: PHS-II, Full Marks: 100, Time: 3 hours]

Group A: NETWORK THEOREM, CURRENT ELECTRICITY AND ELECTROMAGNETIC THEORY

Network Theorem
D.C. circuits: Kirchoff's laws, Thevenin's theorem, Norton's theorem, superposition theorem, maximum power transfer theorem

Current Electricity

Thermoelectricity: Seebeck, Peltier and Thomson effect. Peltier and Thomson's coefficient, laws of thermoelectricity, total emf developed in a thermocouple, thermoelectric curve and the concept of neutral temperature and temperature of inversion of a thermocouple, thermoelectric power, thermoelectric diagram and its applications, uses of thermocouple.

Theory of moving coil dead-beat and ballistic galvanometer.

Mean and RMS value of current and emf in an AC circuit, current in L-R, C-R and L-C-R circuits using operators. resonance in series and parallel L-C-R circuits, power in AC circuits, power factor, wattles current, choke coil and by-pass capacitor, principle of ideal transformer, various losses in transformer.

Electromagnetic Theory

Displacement current, Maxwell's electromagnetic equations, propagation of plane electromagnetic waves in free space, transverse character and polarized electromagnetic wave, Poynting vector, energy density in electromagnetic field, Hertz's experiment.

Group B: ELECTRONICS AND FUNDAMENTALS OF COMPUTER

Electronics
Applications of PN junction diode to half wave, full wave and bridge rectifier, calculation of average current and voltage, RMS current and voltage, ripple and ripple factor, efficiency of half and full wave rectifier, removal of ripples- T and p - filters.

Zener breakdown and Zener voltage, Zener diode and its use as voltage regulator.

Transistors, working of PNP and NPN transistor, current components in a junction transistor, CB, CE and CC configurations and their comparisons.

Transistor characteristics in CE configurations, definition of a, ß and their interrelations. Working of a CE transistor amplifier.

Field effect transistor (FET) and its difference from bipolar transistor, n and p-channel FET, FET operation. FET characteristics: static and dynamic characteristics, FET parameters and their relation, use of FET as a voltage amplifier.

Operational amplifier (ideal): concept of virtual ground, uses of OP-AMP as an inverter, phase shifter, adder, differentiator, integrator, solution of simultaneous equation, real OPAMP – input offset voltage, input offset current, common mode rejection ratio and slew rate.

Feedback amplifiers: positive and negative feedback, voltage gain with feedback, Barkhausen criterion for oscillator, Hartley, Colpitt and Wien Bridge oscillators.

Principle of radio transmission and reception.

Ionosphere: cause of formation, different layers, their role in radio wave propagation.
Digital electronics: Binary system, conversion of binary to decimal and vice versa, binary addition and substraction, Boolean expression, Logic gates (AND, OR, NOT), DDL, DTL.

Combinational circuits, circuit adder & subtractor.

Fundamentals of Computer

Essential parts of an electronic computer: CPU, INPUT and OUTPUT devices.
Computer Memory: idea about primary and secondary memory, RAM, ROM, CD-ROM, HARD DISK, Removable storage devices.

Operating system: Familiarity with different operating systems. Simple Windows commands, simple Linux / Unix commands.

Algorithm and Flow chart for solving simple problems.

Elementary idea about machine, assembly and high level languages, assembler, compiler.

Development of simple programs using BASIC language commands listed: CLS, REM,INPUT, PRINT, assignment statement (LET), READ- DATA, arithmetic logic, DEFFN,GOSUB, IF – THEN, GOTO, FOR – NEXT, FILES (INPUT, OUTPUT, FILE open), DIM, PRINT USING, LPRINT, TAB, LOCATE, END, RUN, SAVE.

Group C: QUANTUM MECHANICS, STATISTICAL MECHANICS AND SOLID STATE PHYSICS

Quantum Mechanics

Black body radiation and discussion of the failure of classical theory with special mentioning of Wien's and Rayleigh-Jeans formula, Plank's hypothesis and Planck's energy distribution law in black body radiation, the variation of specific heat with temperature.

Matter wave, wave function, physical significance of ?, concept of wave packet associated with free particle. Schrödinger time independent equation from the classical differential wave equation in one dimension, one-dimensional representation of position, momentum and energy by quantum mechanical operators, Schrödinger equation using idea of quantum mechanical operator and separation of one dimensional space part and time part. Expectation value of an observable, probability current density, equation of continuity, eigen functions and eigen values, stationary states, orthogonality of eigenfunctions, normalization, fundamental postulates of quantum mechanics, Hermitian property of an operator.

Free particles in one dimensional box, energy level diagram, explanation of continuous energy ocean as a limiting case of discontinuous energy eigen value, degeneracy, zero point energy, momentum and wave function for a free particle in one dimensional box, particle in a finite one dimensional potential barrier.

Statistical Mechanics

Distribution functions for Boltzmann, Bose-Einstein and Fermi-Dirac statistics for a system of non-interacting particles and their comparison.

Solid State Physics

Elementary ideas about crystal structure, concept of lattices and basis, unit cell, fundamental types of lattices, Miller indices, simple cubic, b.c.c. and f.c.c. lattices, reciprocal lattices,
Bragg's equations. Different types and natures of binding: ionic, covalent, molecular, metallic and Van der walls. .

Free electron theory of metals: effective mass, drift velocity, mobility and conductivity, calculation of thermal and electrical conductivities of metals, Wiedmann-Franz law.

Distinction among metals, insulators and semi conductors based on band theory, qualitative discussion on n and p–type semi conductors, Hall effect in conductor.

Magnetic properties of materials: dia-, para- and ferro-magnetic properties of solid, Curie's law, domain structure, temperature dependence of magnetic property, Curie-Wiess law.

Group D: ATOMIC, MOLECULAR AND NUCLEAR PHYSICS

Atomic and Molecular Physics
Measurement of e/m of electron by Thomson's method, measurement of charge of an electron by Millikan's oil drop experiment, positive rays, parabola method, isotopes. Atomic weight, atomic number, atomic mass unit, mass energy equivalence.

Bohr-Rutherford atom model, Bohr's theory of hydrogen spectra, quantum numbers, statement of Pauli exclusion principle.

X-rays: production and properties, continuous and characteristic spectra, Mosley's law and its explanation from Bohr's theory.

Compton effect and calculation of Compton shift.

Photo electricity: definition, features, explanation. Einstein's equation and uses of photoelectric cell.

Vector atom model, space quantization, atomic magnetism, normal Zeeman effect.
Basic ideas about molecular spectra, rotational and vibrational spectra of diatomic molecules, Raman effect and its application to molecular spectroscopy.

Nuclear Physics

Nuclear reaction: Nuclear reaction, conservation principles in nuclear reactions, Q-value and thresholds, exoergic and endoergic reactions, artificial radioactivity, nuclear reactions induced by a-particle, proton, deuteron, ?-rays, neutron. Bohr's postulates of compound nuclear reaction.

Nuclear fission and fusion: Nuclear fission, general characteristics, simple explanation by liquid drop model, energy released in nuclear fission, spontaneous and induced fission, nuclear chain reaction and basic principle of nuclear reactor, nuclear fusion and basic mechanism of energy generation in stars.

Four basic interactions in nature and their relative strengths, examples of different types of interactions. Basic principles of linear accelerator, cyclotron, G.M. counter, cloud chamber (basic principle only).

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5. CHEMISTRY (PAPER-I)

[Paper Code: CEM-I, Full Marks: 100, Time: 3 hours]

GROUP – A (Organic Chemistry)

(a)   General Organic Chemistry: Organic compounds and their classification, nomenclature (trivial and IUPAC). DBE, idea of framing constitution from molecular formula. Nature of bonds and its orbital representation, atomic and molecular orbital – bonding nonbonding and anti-bonding, hybridization, (sp. SP2 SP3) of C,N,O, halogens., bond lengths, bond angles, bond energy, bond polarity, bond polarizability, formation of and   bonds, localized and delocalized chemical bonds. Van der Waals interaction, resonance, resonance energy, steric inhabition of resonance, hyperconjugation, inductive and field effects. H-bonding, dipole moment-bond moment and group moment.

(b)   Isomerism & Stereochemistry: Different types of isomerism (structural & stereo):geometrical isomerism-cis/trans; E/Z and syn/anti nomenclature, and dissymmetry, chirality, elements of symmetry, enantiomers and disatereomers, threo, erythro and meso compounds, representation of molecules in Fischer, flying-wedge, Sawhorse and Newman formule. Relative and absolute configurations, sequence klrules, D/L and R/S systerms of nomenclat ure. Recemic mixure, racemisation, resolution, asymmetric synthesis-Cram's rule and Prelog's rule. Congormational nomenclature – eclipse, staggered, gauche and anti, conformational analysis of ethane, n-butane cylclohaxane.,mono and disubstituted cyclohexanes. Baeyeer strain theory, stability of cycloalkanes.

(c)   Mechanism of Organic Reactions: Bond energy and bond dissociation energy, hemolytic bond cleavages. Structure, stability and formation of electrophilies, nucleophiles and free radicals. Reaction intermediates-carbocations, carbanions. Electrophilic and free radicals addition to C=C, Nucleophilic addition to the C=O group of aldehydes and ketones; Nucleophilic substitution reactions – SN1, SN2 : Electrophilic substitution in the aromatic system ; Elimination reactions – a and B – eliminations, syn and anti-eliminations; E1and E2-mechanism.

(d)   Chemistry of Aliphatic Compounds: Preparation, properties of alkanes, alkenes, alkyknes and alkadienes, alcololls, ethers, aldehydes, ketones, carboxylic acids and their derivatives. Important reactions with mechanism-Markownikoff's additon to alkenes, peroxide effects, ozonolysis, electrophilic and free radical additon to conjugated dienes; 1.2 and 1.4 additions, catalytic hydrogenation of alkenes and alkklynes; use of Lindler's catalyst; Oppenauer oxidation, pinacol-pinacolone rearrangement, Rosenmund reduction. Stephen's reaction, Sommelet reaction. Baeyker-Villiger oxidation, Wolff-kishner reduction, Condensation reactions-Aldol, Claisen and Darzen-glycidic ester; Cannizzaro and Tischenko reactions, Tautomerism, Active methylene compounds, synthesis and synthesic applications of diethyl malonate and ethyl accetoacetate. Preparation and synthetic applications of Grignard reagents, organolithium compounds and organocopper compounds.

(e)   Oganic Compounds containing nitrogen (aliphatic): Methods of synthesis and reactions of nitroalkanes, alkyl nitrites, alkyl cyanides, isocykanides, introduction to amino compounds, general methods of syknthesis, basicity and effect odf sub stituents, chenmical reactivity, distinction and preparation of primary, secondary and tertiary amines, important aliphatic amines.

Group – B
(a)   Aromatic hydrocarbon and aromaticity: Sources, nomenclature and isomerisation of aromatic compounds, structure of benzene, stability of benzene ring, molecular orbital picture of benzene, aromaticity. Huckel's (4n + 2)rule and its simple applications. Electrophilic substitution reactions in aromatic compounds. General mechanism of aromatic electrophilic substitution effect of subsituent groups, directive influence, orientation, isotope effect, nitration, sulphonation, halogenation. Friedel-Craft's alkylation and acylation, energy profile diagram, nuclear and side chain halogenation.

(b)   Aromatic Compounds: halogen compounds- Introduction, method of synthesis, physical properties, chemical reactivity, necleophilic aromatic substitution and its mechanism. Aromatic ompounds containing nitrogen- Introduction methods of synthesis and physical properties, mechanism of nitration, reduction products ofnitro compounds. Introduction, methods of synthesis of aromatic animes, basicity and effect of substituents, chemical reactivity. Diazotization and reactions of diazoium salts. Phelols – Synthesis, physical properties, acidic character, chemical reactions, Kolbe reaction. Reimer – Tiemann reaction, Fries rearrangement. Claisen rearrangement. Houben – Hoesch reaction, phenol-formaldehyde resin, cresols, nitro and amino phenols, dihydric and trihydric phenols. Aromatic aldehydes, ketones – Introduction, methods of synthesis, physical properties, chemical reactivity of aromatic alcohols. Aldehydes ad ketones, Perkin reaction, phenolic aldehydes, Benzoin condensation.

(c)   Chemistry of Biomolecules: carbohydrates – Introduction, occurrence, classsification, nomenclature. Reactions of glucose and fructose, osazone formation, mutarotation and its mechanism, cyclic structure – pyranose and furanose forms, determination of ring size. Haworth projection formula, configuration and conformational analysis of monosaccharides, anomeric effect, epimerization, ascending and descediing of sugar, interconversion of aldoses and ketpses/ Proteins – methods of synthesis, physical and chemical properties and structures of common alpha animo acids. Isoelectric points, peptide synthesis.

(d)   Heterocyclic compounds: Introduction,   five   and   six   membered heterocycles, aromatic character, nomenclature, structure, synthesis and chemical reactivity of furan, pyrrole, thiophere, pyridine and piperudubem basucuty of pyrrole, pyridine and piperidine. Introduction to condensed five and membered heterocycles, synthesis and recativity of indole and quinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler napieralsky synthesis.

(e)   Spectroscopy: Ultraviolet and visible spectroscopy – Introdution theory, solvent effects, characteristic absorption of organic compound, application of rules of calculation of nmax of polyenes and dienones. Infared spectroscopy – Introduction theory, characteristic group frequencies of organic molecules, factor affecting group frequencies. Proton NMR spectroscopy – Introduction, theory, chemical shift and factor influencingit, spin-spin coupling, characteristic chemical shift values of different kind of protons, application of UV, IR and NMR in structure elucidation of organic molecules,

Group-C(Physical Chemistry)
1.   Gaseous State: Postulates of Kinetic theory of gases and equation ($PV = 1/3\ mnc2$, collision number and mean free path, Deviation from ideal behaviour of real real gases and causes of deviation, van der waal's equation of state of real gases, critical constants, Liquefaction of gases, Concept of root mean swuare velocity, average and most probable Velocities, Mazwell distribution of molecular velocities (including effect of temperature), Bollzman distribution equation.

2.   Liquid State and Solution Properties: Physical properties of liquids including their experimental methods of determination, internal and vapour pressure, viscosity, surface tension, Effect of temperature of these properties, Capillary action, Liquid crystal and their structures. Colligative properties of dilute solution, elevation of boiling point, depression of freezing point, osmotic pressure, Determination of molecular weight of substances based on colligative properties, Abnormal solution properties and Van't Hoff factor.

3.   Crystalline State : Laws of crystallography, space lattice and Unit cell, Weiss and Miller indices, seven crystal system, 14 Bravais lattices, symmetry elements, X-ray diffraction of crystals – Bragg's equation, Analysis of simple crystals (Kcl, Nacl, icc, graphite etc), Crtstak defects- Schottky and Frenkel defects, Semcondondutors (n and p – type).

4.   Thermodynamies: Basic thermodynamic concept – system, surroundings, various type of systems and processes, thermodynamic functions of state and variables, Thermodynamic lows – zeroth, First, Second and Third lows, Joule-Thomson effect, Laws of thermochemistry, concept of enthalpy, entropy, free energy, Gribbs potential Thermodynamic criteria for spontaneity and equilibrium, Entropy and probability.

5.   Chemical Kinetics: Order and molecularity of reactions, differential and integral rate equations for zeroth, first and second order reactions, consecutive, opposing and thain reactions, Ionic reactions and kinetic salt effects, Arrhenius equation and concept of activation energy, collision theory and Transtion state theory of reaction rates Catalysis – Acid base catalysis, enzme calalysis, Application of Catalysis in industries.

Photochemistry – Laws of photochemistry, optical density, quantum yield, photosensitized reactions, photoluminerscence.

Group – D(Physical Chemistry)

1.   Chemical equilibrium: The law of mass action, equilibrium constants (Kp,Kc and Kx), Le-Chatelier principle an its application, Equilibrium constant and free energy change (the reaction isotherm), The temperature dependence of the equilibrium constant – Van't Hoff equation, Equilibrium in phases – Clapeyron equation and calvsius.

2.   Surface Phenomena: Absorption and adsorption, physical and chemical adsorption, surface tension and adsorption, surface films, Liquid and solid interfaces, Applications of adsorption. Colloid and crystalloid, optical, electrical and kinetic properties of colloids, dialysis, functioning of soap and detergents, micelle formation, emulsions.

3.   Electrochemistry: Specific and equivalent conductance of solutions, transport number, Kohlrausch law and its application, Debye – Huckel theory of strong electrolytes, ionic strength, Debye – Hockel lomiting law, conductometric litration, PH, Buffer solution, solubility product principal and common ion effect, Type of indicators. Electode potential, Nerrsgt equation reference electrode, setting up of cells, cell reaction ad e.m.f. of cells, Liquid junction potential and salt bridge.

4.   Macromoecules: Type of macromolecules, properties of macromolecular solutions Degree of polymerization of moleculr weight y eifferent methods like viscometry,osmometry etc. Type of polymerization reactions and corresponding mechanism, crystallinity of macromolecules, uses of macrimolecules.

5.   Molecular spectra: Interaction of matter with electromagnetic radiation, Dffierent froms of energy in molecules – translational, rotational, vibrational and electronic, Born – oppenheimer Approximation, Types of spectra – absorption and emission spectra, atomic or line spectra and molecular or band spectra, selection rules, Rotational spectra of diatomic molecules, vibrtional spectra (Harmonic and anharmonico viations), Raman spectra (Stokes and anti stokes lines), Applications of rotational, vibrational and raman spectra.

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6. CHEMISTRY (PAPER-II)

[Paper Code: CEM-II, Full Marks: 100, Time: 3 hours]

Group – A (Inorganic Chemistry Unit – I)

1. Structure of Atom: Bohr's atomic theory including simple mathematical treatment for radius and energy for hydrogen atom, Sommerfield's modifications Quantum number and their significance, Aufbau Principle, panli's exclusion principle, Hund's rule, electronic configuration of the elements, hydrogen spectra. Qualitative idea and simple numercals on pho0roclectric effect and Comton effect, wave-particle dualilty, de Broghe's relationship, Heisenberg's uncertainity principle, Schrodinger wave equation for stationary states (including derivation), significance of X and X^2, probabililty distribution craves and shapes of D1 p and d-orbitals

2. Nature of Chemical Bonding

Ironic Bond: Lattice energy and Born-Haber cycle,solation energy and solubility of ionic solids, Fazan's rule and polaristion.

Covalent Bond: Valence Bond theory of bonding various types of hytridisation, VSEPR theory, shapes of inorganic molecules and ions.

Molecular orbital theory (MOT) of bonding , M.O. fiohtsmd got homo-diatonric (H_2,B_2,C_2,N_2,O_2,F_2) and hetero-diatomic (CO, NO,HF) molecules and their M.O. electronic configurations Hydrogen bonding and its consequences.

3. Periodic Laws and periodic properties of Elements: Old and Modern Periodic Law, Modern Classification of elements into 18 groups, classification of elements on the basis of electronic configuration periodicity of properties – valency, atomic redii ionic radii, ionization energy, election affinity, electrone galivity density, melting and boiling points, position of hydrogen in the periodic table.

4. Acids and bases: Modern theories of acids and bases Bronsted and Lowery Concept, Lew's Concept, SHAB Principle, strength of acids and bases PH – Calculation of acids or bases.

Redox Reaction: Electronic Concept of oxidation and reduction reactions, Ion electron method of balancing redox reactions, Redox potential and its applications precipitation and complex formation on redox potential, Redox titrations and choice of indictors in redox titrations, Reactions of potassium permanganate, potassium dichromate and potassium iodate per acids and per salts.

5. Nuclear Chemistry: Possible forces operated between n-n, p-p and n-p and magnitude of nuclear forces qualitative idea and stability of nucleus (n/p ratio),Binding energy, mass defects, packing fraction, finsteins mass-energy relation (including simple numerical).

Natural and artificial radioactivity rate law of radioactive disintegrations, radioactive decay radiations, group displacement law, half life and its application in age determination, applications of radioactivity, nuclear fission and nuclear fusion reactions.

Group – B (Inorganic Chemistry Unit-II)
1. S- Block Elements : Comparative study of the elements of each group of S-block elements with respect to ionic radii, ionisation, melting and boiling points, hydration energy, chemical reactivity, solubilities of their c9ompounds, anomalous behaviour of lithium and beryllium and its compounds.

2. P- Block Elements: Comparative study of the elements of each group (13th to 18th group) with respect to ionic radii ionisation energies, electron affinities, electro negativity, chemical reactivity, allotropic forms of carbon phosphorus and sulphur, important compounds such as hydra and oxyacids of elements of group 15th to 17th , compounds of noble gases (group – 18) and their stereochemistry.

3. Coordination Compounds: Double salts and complex salt, detection of complex formation in solution by job's continuous variation method, stability of complexes and its determination by Bjerrum's method.

IUPAC nomenclature of coordination compounds, stereochemistry of different coordination humbers, chelating and non-chelating legends, special properties of chelates (Chelate effect), Werner's coordination theory and effective atomic rule, valence bond and crystal field theories of complex compounds and their applications in explaining its properties such as structure, magnetic properties and colour of octahedral and square planer complexes, use of coordination compounds in medicines (mental chemotherapy).

4. d and f Block Elements: Comparative study of properties of d and f block elements with respect to their electronic configuration, oxidation states, complex formulation, magnetic properties and electronic spectra (Qualitative only), isolation of lanthanides, lanthanide contraction and its consequences.

5. Organometallics: Ligand (1 to 6 electron donors) used in the synthesis of organometallics, heptacity of organic ligands (n1, n2, n3, n4, n 5 & n6) 6 – bonded organometallics and their properties, n – banded organometallics and their properties, synthesis and properties of zeises salt and ferrocene.

Bio-Inorganics : Essential and trace elements in biological systems, metalloprophyeins – Chlorophyll, heme protein and vitamin B-12, Basis chemical reactions in biological systems (Photosynthesis and respiration)

Group – C (Industrial Chemistry)
1.Fuels :Classification of fuels, calorific value of fuels, origin and composition of coal, carbonization and gasification, economic importance of coal. Origin and composition of gaseous fuels, fractionation and cracking of petroleum, liquid petroleum gas (LPG), flash point, octane numer, ectane number, knocking, anti knocking compounds

2. Fats and Oils, Soaps and Detergent: Natural fats, edible and industrial oils of Vegetable origin, classification bases on drying property, evaluation of quality of oil –acid value, manufacture of Vanaspati. Washing and toilet soaps (preparation and uses), synthetic detergents – alkyl and aryl sulphonates, fatty alcohol sulphonate, non ionic detergent.

 3. Water and its conditioning: Physical and Chemical properties of water, Hard and soft water, determination of BOD and hardness of water, classical and modern methods of water conditioning – ion exchange, electro dialysis, reverse osmosis, chlorination, fluorination and ozonation.

4. Fertilizers : Requisites of good fertilizers, classification of fertilizers – direct and indirect fertilizers, complete and in complete fertilizers, nitrogenous fertilizer, phosphatic fertilizer, Potash fertilizer role of nitrogenous, phosphatic and production of produce, manufacture and uses of urea and super phosphates.

5. Polymers: Polymers and its classification, natural and synthetic polymer, comparison of organic and inorganic polymers, types of polymerisation, manufacture and application of natural and synthetic rubber synthetic fibres such as polyester, polyamide, polyacrylate, manufacture and application of silicones.

Group-D. (Environmental Chemistry)
1. Environment of the planet earth: Biotic and a biotic components of environment and their interdependence, composition of atmosphere, hydrosphere and lithosphere, green house effect, natural cycles (hydrological cycle, oxygen cycle, nitrogen cycle, carbon cycle, phosphorus cycle) deforestation and its environmental consequences.

2. Air Pollution: Composition of unpolluted air, sources of air pollution, primary air pollutant, carbon monoxide in made pollutant, mechanism of formation of photochemical smog and acid rain, effect of primary pollutants, smog and acid rain on environment.

3. Water Pollution: Difference between polluted and unpolluted water, water budget and hydrological cycle, water pollutant – organic pollutants, inorganic pollutants, sediments, thermal pollutant and radioactive pollutant, Assessment of quality of water with the help of D.O. (dissolved oxygen), BOD (biological oxygen demand) and COD (Chemical oxygen demand), effect of polluted water on human health chemical speciation of mercury and arsenic in water.

4. Soil Pollution: Composition of soil, sources of soil pollution, types of soil pollutants, effect of pollutants on soil fertility and production of food materials, remedies to control soil pollution.

5. Global Environmental issues: global warming and reduction in emission of green house gases, climate charge, ozone hole, sea-level rise, disposal of nuclear wastes, species at risk.

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7. BOTANY (PAPER-I)
[*Paper Code: BOT-I, Full Marks: 100, Time: 3 hours*]

Group – A: Microbiology and Plant Pathology:

Structure and reproduction/multiplication of bacteria, viruses, and mycoplasma; Prion hypothesis; Applications of microbiology in agriculture, industry and Role of microbes in controlling pollution of air, soil and water. medicine;

Important crop diseases caused by viruses, bacteria, mycoplasma, fungi and nematodes; Modes of infection and dissemination; Diseases of rice (Brown spot), wheat (Black stem rust), potato (Late blight), Ground nut (Tikka disease), Chemical and biological control of plant diseases; Plant quarantine. Fungal toxins; Disease forecasting.

Group – B: Cryptogams:

Structure, reproduction and economic importance of algae, fungi, lichens, bryophytes and pteridophytes: Thallus organization in algae, Origin and evolution of sex in algae, Life cycle patterns in algae; Sexuality in fungi; Mushroom Cultivation (paddy straw).Evolution of sporophyte in bryophytes; Telome theory, apospory and apogamy, heterospory and origin of seed habit

Group –C: Phanerogams:

Classification and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their structure and reproduction; General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Type of fossils and their study techniques.

Taxonomic hierarchy; International Code of Botanical Nomenclature; Numerical taxonomy and chemotaxonomy; Evidence from anatomy, embryology and palynology.

Origin and evolution of angiosperms; Comparative account of various systems of classification of angiosperms; Study of angiospermic families – Mangnoliaceae, Ranunculaceae, Cesalpiniaceae, Miomosaceae, Fabaceae, Euphorbiaceae, Malvaceae, Apiaceae, Acanthaceae ,Lamiaceae , Solanaceae, Rubiaceae, Cucurbitaceae, Asteraceae, Poaceae, Liliaceae, Zinziberaceae and Orchidaceae.

Structure and function of primary and secondary tissues; Structure and function of cell wall, Stomata and their types; normal and Unusual secondary growth; Wood anatomy.

Development of male and female gametophytes, post fertilization changes leading to the development of Embryo and Endosperm; Polyembroyony and apomixes.

Group – D: Plant Resource Development and morphogenesis:

Origin of cultivated plants; Plants as sources for food, fodder, fibre, spices, beverages, edible oils, drugs, narcotics, insecticides, timber, gums, resins and dyes, latex, cellulose, starch and its products; Perfumery; Importance of Ethnobotany in Indian context; Energy plantations, petrocrops and biofuels;

Totipotency, polarity, symmetry and dfferentiation; Cell, tissue, organ, haploid and protoplast culture; Somatic hybrids and Cybrids; Micropropagation; Somaclonal variation.

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8. BOTANY (PAPER-II)
[Paper Code: BOT-II, Full Marks: 100, Time: 3 hours]

Group – A: Cell Biology and Molecular Biology:

Prokaryotic and eukaryotic cells - structural and ultra-structural details; Structure and function of cell organelles (chloroplasts, mitochondria, ER, dictyosomes ribosomes, lysosomes, peroxisomes); Cytoskeleton and microtubules; Nucleus, nucleolus, nuclear pore complex; Chromatin and nucleosome; Mitosis and meiosis; Molecular basis of cell cycle; Structural variations in chromosomes and their significance; Chromatin organization and packaging of genome; B-chromosomes –, behaviour and significance; Structure and synthesis of nucleic acids and proteins; Genetic code and regulation of gene expression – Lac operon and tryptophan operon; Gene silencing.

Group – B: Genetics, Plant Breeding and Biotechnology:

Gene versus allele concepts (Pseudoalleles); Quantitative genetics and multiple factors; Incomplete dominance, multiple alleles; Linkage and crossing over; Methods of gene mapping, Restriction mapping (Idea of Restriction map); Sex chromosomes and sex-linked inheritance, sex determination; Mutations (biochemical and molecular basis)

Methods of plant breeding – introduction, selection and hybridization (pedigree, backcross, mass selection, bulk method); Polyploidy, male sterility and heterosis breeding;

DNA sequencing; Genetic engineering – methods of transfer of genes; Transgenic crops and bio-safety aspects; Use of molecular markers in plant breeding; Tools and techniques – southern, northern & western blotting, DNA fingerprinting, PCR and FISH

Group – C: Physiology and Biochemistry:

Water relations, mineral nutrition and ion transport, mineral deficiencies; Photosynthesis – photochemical reactions; photophosphorylation and carbon fixation pathways; C3, C4 and CAM pathways; Mechanism of phloem transport; Respiration (anerobic and aerobic, including fermentation) – electron transport chain and oxidative phosphorylation; Photorespiration; Chemiosmotic theory and ATP synthesis; Nitrogen fixation;

Enzymes,Coenzymes; Importance of secondary metabolites; Pigments as photoreceptors (plastidial pigments and phytochrome); Plant movements; Photoperiodism and flowering, vernalization, senescence; Growth substances – their chemical nature, role and applications in agri-horticulture; Stress physiology (heat, water, salinity); Fruit and seed physiology; Dormancy, storage and germination of seed

Group – D: Evolution, Ecology and Plant Geography:

Organic evolution – evidences, mechanism and theories, Role of RNA in origin and evolution. Concept of ecosystem; Ecological factors; Concepts and dynamics of community; Plant succession; Concept of biosphere; Ecosystems; Conservation; Pollution and its control; Plant indicators; Environment (Protection) Act.

Forest types of India - Ecological and economic importance of forests, afforestation, deforestation and social forestry; Endangered plants, endemism, IUCN categories, Red Data Books; Biodiversity and its conservation; Farmers' Rights and Intellectual Property Rights; Concept of Sustainable Development; Biogeochemical cycles; Global warming and climatic change; Environmental Impact Assessment; Phytogeographical regions of India.

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9. ZOOLOGY (PAPER-I)

[Paper Code: ZOO-I, Full Marks: 100, Time: 3 hours]

Group- A

Non Chordates & Chordates
- Outline Classification of Animal Kingdom.
- Histology of Body Wall & Canal system in spones (Syconoid Type).
- Cnidaria: Polymorphism in Siphonophore.
- Water vascular system in Echinodermata.
- Structure of pharynx and ciliary mode of feeding in Amphioxus.
- Life history of Ascidia.
- Poisonous and non poisonous Snakes.
- Feeding and biting mechanism in Snakes.
- Comparative study of heart in vertebrates.
- Animal colouration and mimicry.

Group- B

Economic Zoology & Parasitology
- Pisciculture: Principles & practice of composite fish culture; Induced breading methods involved- advantages/disadvantages.
- Prawn Culture.
- Sericulture.
- Vermiculture & Vermicomposting: Suitable species, technique & importance.
- Life history, pathogenecity and control measures of:
i) Plasmodium sp (P.vivax & P.falciparum).
ii) Entamoeba histolytica.
iii) Wuchereria bancrofti/ Ancylostoma duodenale .
- Parasitic adaptation in helminthes.
- Acquired Immuno Deficiency Syndrome:
i) Causative Agent. [ii]   Symptomes. [iii] Mode of Transmission.
iv) Remedial Measures.

Group- C

Biodiversity & Wild Life Conservation
- Concept of Biodiversity, hierarchial levels- Genetic diversity, Species diversity, Community and ecosystem diversity (alpha-beta & gamma diversity; Causes of depletion of biodiversity.
- Biodiversity as a resourse.
- IUCN threat categories- critically endangered, endangered, vulnerable & rare species. Hot spots of biodiversity.
- Strategies for Conservation of Biodiversity (ex situ and in situ methods). CITES, Wild life protection acts, protected areas, Biosphere reserves, National Parks & Santuries.
- Conservation of i) Rhino, ii) Elephant.
- Santuries and Wild Life (Schedule- I animals) in Tripura.

Group- D

Evolution & Ecology
- Hardy-Weinberg principles & factors influencing changes in the gene frequency. Natural selection: stabilizing, directional & disruptive selection with examples and evolutionary significance.
- Isolative mechanism.
- Modes of speciation: Allopatric, Parapatric and Sympatric.
- Ecosystem: a) Components, b) Energy flow c) Food chain d) Pyramid of biomass, number & energy.
- Population properties.
- Air pollution: Green house effect, global warming & remedial measures.
- Water pollution: Sources, parameters for measuring pollution level- BOD, COD, TOD; Eutrophication- the process and effects(physicochemical & biological); Bioaccumulation & biomagnification.

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10. ZOOLOGY (PAPER-II)
[Paper Code: ZOO-II, Full Marks: 100, Time: 3 hours]

Group- A

Histology & Embryology
- Histology and functions of – i) Pituitary ii) Thyroid iii) Pancreas iv) Adrenal.
- Gametogenesis.
- Fertilization.
- Cleavage, gastrulation and formation of foetal membranes in chick.
- Placenta : Types, formation (Rabbit) and functions.

Group- B

Biochemistry & Animal Physiology
- Classification of carbohydrate, protein and lipid; structure and function of carbohydrate and protein.
- Enzymes.
- TCA Cycle.
- Transport of O_2 and CO_2 in the blood of mammals.
- Temparature regulation in endothermal mammals.
- Heat balance and role of hypothalamus.
- Estrous cycle & its hormonal control.
- Biological rhythm: types, example & mechanism.

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Group- C

Biophysics & Biostatistics

• Thermodynamics: Laws, Concept of enthalpy, free energy and entropy and their relationship; Living body as thermodynamics system.
• Molecular transport across membrane.
• Nurve impulse generation, synaptic transmission.
• Ionising radiation & its biological effects: Radioactivity, sources, radiation unit- R, Biological application of radio isotopes, Biological effects of radiation- dose response relationship (target Theory), effects at molecular level, cellular level and carcinogenesis.
• Basic concept of Biostatistics- Central Tendency, concept of mean, median & mode.
• Elementary concept of probability a) standard error b) standard deviation c) chi-squre test d) t-test e) simple correlation coefficient.
• Simple graphical representation of statistical data.

Group- D

Cytology & Genetics
• Structure and functions of cell organelles:
i) Cell membrane ii) Golgi apparatus iii) Mitochondia iii) Endoplasmic reticulum.

• Nucleic acid:
i) Chemistry and structure of DNA and RNA.
ii) Replication of DNA (Prokaryotic).
iii) Transcription and translation (Prokaryotic).
• Chromosome (Ultra structure)-Nucleosome Model.
• Linkage and crossing over, Sexlinked inheritance, sex determination in Drossophila and Man.
• Congenital abnormalities in Man: Colour blindness, albinism, Down Syndrome, Turner syndrome and klinefelter syndrome.
• Multiple Allele and ABO blood group.
• Cytology and Genetic basis of cancer
i) What is cancer? Types of Cancer
ii) Characteristics of cancer cells
iii) Development of cancer and cancer causing factors
iv) Concept of oncogene & proto oncongene
v) Transfomation of proto-oncogene to oncogene.

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11. PHYSIOLOGY (PAPER-I)
[*Paper Code: PHY-I, Full Marks: 100, Time: 3 hours*]

Group A : Biophysical and Biochemical Phenomena and Biometry.

1. Resting membrance potential — genesis of resting membrane potential (RMP). Action potential – Mechanism of development of AP.
2. Active transport : Definition, various forms, basic mechanism of active transport, osmolality and osmolarity. Importance of osmosis in Medicine and Biology.
3. Donnan membrane equilibrium and its biological significance; relation with osmotic pressure, mebrane hydrolysis and pH.
4. Colloids — Classification, properties, importance in biological system, protective colloids, sol & gel phenomenon.
5. pH, Buffer, different buffer systems of human body, Determination of pH of a buffer solution by Henderson – Hasselbalch equation and Hydrogen electrode method.
6. Concept of biostatistics and its application in physiology.
7. Frequency distribution.
8. Graphical representation of data.
9. Measures of central tendencies – Mean, median, mode.
10. Measures of dispersion – Range, quartile, mean deviation, standard deviation
11. Correlation – correlation coefficient & rank corelation; Regression – linear.
12. Chi-square test for independence.
13. Test of segnificance – concepts of hypothesis, concepts of SE; T-test.

Group B : Blood, Immune System and Cardio Vascular System.

1. Plasma protein: Formation, Principles of separation and function; Formation of R.B.C and W.B.C, factors controlling R.B.C. formation; structure, formation and fate of Haemoglobin, Anaemia – Classification, causes and preventive measures. Blood Coagulation, Clotting disorders.
2. Blood volume – its measurement. Blood groups and Rh factors, determination of different groups and factors. Importance & hazards of blood transfussion, compatibility and incompatibility of blood transfussion. Importance of voluntary blood donation. Blood borne diseases.
3. Body Immunity – definition and types of immunity. Types of Acquired immunity: Cellular immunity, Humoral immunity – developmental approach. AIDS, different types of vaccinations.
4. Structure and properties of cardiac muscle, Junctional tissues, Factors affecting heart rate, regulation of Heart rate. Cardiac cycle – Pressure volume relationship. Blood Pressure – Factors affecting regulation, Heart sounds – origin and siginficance.
5. Cardiac output – influencing factors, measurement.
ECG - waves, leads; concepts of hypertension, atherosclerosis, angina pectories, Coronary heart disease (CHD), Cardiac failure.

Group C :   Respiration, Digestive system, Nutrition and dietetics.

1. Mechanism of respiration with special reference to respiratory muscles involved.
2. Lung volumes & capacities – measurement and significance; spirometry.
3. Transport of O_2 and CO_2, Nature and significance of Oxyzen dissociation curve.
4. Artifical respiration.
5. Regulation of respiration – anatomical postion of respiratory centres, neural regulation, chemo receptors and chemical regulation of respiration.
6. Acclimatization at high attitude, mountain sickness.
7. Effect of smoking as pollutant – passive smoking
8. Formation and Secretion of HCl; achlorohydria.
9. Digestion of Carbohydrate, protein and Fat, modern concept of fat absorption.
10. Digestive juices – compostion, function, formation and regulation of secretion.
11. B.M.R. – factors affecting BMR, determination of B.M.R.
12. Biological functions of – Na^+, K^+, Ca^{++}, F^{++}.
13. Biological value of protien, Diet survey – Definition, different types and signficance.
14. Diet in pregnancy and in protien calorie malnutrition. Physiology of starvation.

Group D :   Biochemistry, Enzymology and Metabolism

1. Isomerism of Monosaccharides, Polarimetry; Phosphotipids, glycolipids, lipoprotiens – their characteristics, classification and functions, prostaglandins.
2. Structure of Protiens.
3. Ribozymes; Activation energy : Enzyme catalyzed reactions. Enzymes for rate limiting steps : charateristics. Concepts of dissociation constant – pK values: signficance. Kinetic properties : Km value, V_{max}, determination of Km value and V_{max} of an enzyme. Effects of temperature, substrate concentration and pH on enzyme action. Regulation of Enzyme action – covalent modification, Allosteric regulation. Multi enzyme complex and its significance. Enzyme inhibitors, Isozymes, Co-enzymes and Co-factors.
4. Gluconeogenesis, Cori cycle, Pentose phosphate pathway, TCA cycle, integration of Carbohydrate, Protein and fat metabolism through TCA cycle. Urea biosynthesis.
5. Biological oxidation – reduction.
6. Oxidation of fatty acids.
7. Formation, fate and functions of Ketone bodies.
8. Protein biosynthesis.

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12. PHYSIOLOGY (PAPER-II)
[Paper Code: PHY-II, Full Marks: 100, Time: 3 hours]

Group A : Musculo skeletal system, Nerve muscle Physiology.

1. Macro molecular structure of skeletal muscle. Red and White muscle fibres : Their characteristics. FT and ST fibres.
2. Modern concept of mechanism of Contraction of skeletal muscle. Isotonic and Isometric Contraction. Hypertrophy, Dystrophy and Rigor mortis.
3. Ossification of bones – Spongy bone and Compact bone, Arthritis and Osteophorosis.
4. Joints – types, description and function.
5. Degeneration and regeneration of nerve fibre.
6. Propagation of nerve impulse in myelinated and nonmyelinated nerve fibre.
7. Structure of synaptic junction, classification, transmission of nerve impulse across the synaptic junction.
8. Structure of Neuromuscular junction, propagation of impulse across the neuromuscular junction; Motor unit, E.P.S.P. and IPSP.

Group B : Nervous System and Special Sense.

1. Receptors – classification
2. Reflex action – classification, reflex arc, General characteristics of reflex action.
3. Ascending tracts : Tracts of Goll – Burdact, Lateral spinothalamic tract. Anterior spinothalamic tract.
Descending tracts : Pyramidal tract, upper motor neuron and lower motor neuron, Reticulospinal tract.
4. Functions of the spinal cord with special reference to complete and hemisection.
5. Cerebral circulation.
6. Functions of hypothalamus and cerebellum.
7. Physiological basis of E.E.G and different waves.
8. Histology of retina, Photochemical changes in retina on exposure to light.
9. Propagation of sound through different parts of ear and their role in hearing. Discrimination of sound frequencies and loudness.
10. Hazzards of sound pollution on hearing.
11. Concepts of primary and secondary colours. Theories of colour vision, colour blindness.

Group C : Endocrinology and Reproductive Physiology.

1. Hormone receptors – Different types of hormone receptors and their mode of actions.
2. Mechanism of action and regulation of secretion of hormones – Thyroxine, Steroidal hormones.
3. Physiological functions of – Thyroxine, Insulin, adrenocoid hormones, Thymus and pineal gland, posterior pituitary hormones.

4. Endocrine control of blood sugar level, Glucose tolerance test and its significance.
5. Histological structure of testis and ovary.
6. Spermatogenesis and Oogenesis.
7. Menstrual Cycle – hormonal regulation.
. Histology and development of Mammary gland, Physiology of lactation, milk ejection.
9. Endocrine role of placenta.
10.   Fertility control and its social impact in India.

Group D : Excretory system, skin and body temperature, Ergonomics & work physiology

1. GFR – factors affecting, JG apparatus – structure, function.
2. Hypertonic urine formation with reference to anatomical peculiarities of renal tuble.
3. Physiology of Micturition.
4. Acid-base regulation by kidney and role in R.B.C. formation.
5. Histological structure and functions of skin.
6. Sweat gland, sebaceous gland and regulation of sweet secretion. Insensible perspiration.
7. Body temperature regulation – Heat loss and Heat gain, neural control of body temperature.
8. Scope and application of ergonomics and work physiology; static and dynamic work : Classification of work and exercise.
9. Fatigue – causes, factors affecting onset of fatigue.
10.   Energy cost of Physical activity. Cardio vascular & respiratory chauges during exercise.
11.   Effects of training on muscle, cardiovasour & respiratory system. Concept of O_2–debt & VO_2-max.

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13. AGRICULTURE (PAPER-I)
[*Paper Code: AGR-I, Full Marks: 100, Time: 3 hours*]

GROUP- A

1. Agriculture in India, its importance in national economy
2. Basic elements of crop production. Factors determining crop production
3. (a) climate (b) Agro-Ecological Zones (c) Geographical distribution of crops (d)soil (e) physiographic (f) biotic
4. Geology of Indian sols
5. Soil formation processes and factors responsible for soil formation from the parent rock.
6. Environmental pollution, causes and effects on agriculture and different measures to be adopted to control environmental pollution.

GROUP-B
(I)
1. Renewable & non-renewable natural resources and their scientific management.
2. Importance of soil as a medium for crop production
3. The soil composition, its mineral and organic constituents and their role in crop production
4. Acid soils, their characteristics, availability of nutrients and management. Soil fertility and productivity
5. The essential plant nutrient, macro, secondary and micronutrient elements
6. The functions of different plant nutrients in crop production
7. The essential plant nutrients, their occurrence and factors affecting availability to plants
8. Different approaches in soil fertility evaluation. Soil testing and its utilization for judicious application of fertilizer for optimum crop production
9. Integrated nutrient management with special reference to organic manure and bio-fertilizer
10. Straight fertilizer, complex fertilizer, mixed fertilizer and liquid fertilizer manufactured and marketed in India- reason for importing of some straight fertilizers from foreign countries

(II)
1. Soil Conservation planning on watershed basis
2. Soil erosion and land degradation
3. The factors responsible for soil erosion and the extent of soil loss
4. Runoff management and soil conservation measures adopted in hilly terrain, foothills and valley lands
5. Dryland agriculture and its problems
6. Technology for sustaining agricultural production under rain fed condition in Tripura
7. Efficiency of utilization of rainwater and assured irrigation in relation to crop production
8. Methods of irrigation- Surface, sprinkler and drip. Scheduling of irrigation

9. Quality of irrigation water
10. Methods of reducing losses of irrigation water
11. Reclamation of water logged soil and its importance of proper drainage in regular assured irrigated area.

GROUP-C
(I)
1. Package of practices for production of important cereals, pulses, oilseeds, and fiber and commercial crops
2. Concepts of different cropping pattern, cropping system, crop rotation and their role in increasing crop production
3. Jhum cultivation and possibility of an alternative farming system for jhuming
4. The importance of agro forestry and social forestry
5. Herbicides their characteristics and use in weed management. Integrated weed management. Commonly used herbicides in India and Tripura.

(II)
1. Scope, importance and characteristics of all farm management
2. Farming, planning and budgeting
3. Economics of different types of farming systems
4. Problems and prospects of Agricultural marketing
5. Importance and assessment of credit requirement in agriculture
6. Role of co-operatives in agricultural economy
7. Marketing and pricing of agricultural inputs (seeds, fertilizer and PPC) and Output (production)
8. Importance of seed technology- processing, testing and marketing of seeds

(III)
1. Farm mechanization and its role in agricultural production and rural employment
2. Basic knowledge of farm implements
3. Evaluation of agricultural extension activities in National production programme
4. Importance of socio-economic survey in agricultural production
5. Women in agriculture, multifaceted roles and tasks
6. Capacity building of extension personnel, self Help group and farmers
7. Role of farmers training centers and Krishi vigyan Kendras
8. Cyber Extension

GROUP –D
1. Global warming and its impact on agriculture
2. National and international agricultural research institutes in India
3. Basics of weather forecasting
4. Biodiversity and its conservation
5. Sustainable Agriculture
6. Organic farming and its relevance in present context
7. Energy management in agriculture.
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14. AGRICULTURE (PAPER-II)

[*Paper Code: AGR-II, Full Marks: 100, Time: 3 hours*]

Group-A

1. Elements of genetics and plant breeding as a means of crop improvement.
2. Principles and methods of breeding of important agricultural and horticultural crops
3. Behaviour of self pollinated and cross pollinated crops and their differences.
4. Male sterility and self incompatibility and their utility in crop improvement
5. Biotechnology in Agriculture and horticulture; its concept, scope and importance
6. Methods of breeding for vegetatively propagated crops.

GROUP-B

1. Study of Agro climatic zones in relation to development of Horticulture
2. Lay out and design of orchard, High density planting systems in horticulture Advantages and disadvantages
3. Propagation techniques in horticulture- sexual and asexual,apomixis methods including polyembryony and Differennt types of training and pruning in horticultural crops; definition,importance and their various methods
4. Use of growth regulators in horticulture
5. Cultivation methods of major fruit, plantation crops, spices, medicinal plants under Tripura condition with particular reference to- varities,method of layout, spacing, digging of pits, manures and fertilizers,yield.
6. Cultivation methods of major winter and summer vegetables under the following heads-nursery,land preparation,varieties,seed/seedling requirements, spacing, broadcasting /transplanting,manures and fertilizer, yield.
7. Package of Practices of growing major flowers.
8. Lawn making and Commercial floriculture with Anthurium,Gerbera,Orchids.
9. Importance of post harvest management of horticultural crops and factors responsible for deterioration of horticultural crops and different methods to minimize losses.
10. Different methods of fruit and vegetable processing including value addition.

GROUP-C

1. Important pests of major agricultural and horticultural crops and their bio-ecology including nature & symptoms of damage and their management
2. Important diseases of major agricultural and horticultural crops and their causal organisms , epidemiology ,symptomatology and their management
3. Rodent pests and non insect pests of crops-their management
4. Survey and surveillance of pest including agro ecosystem analysis.

5. Importance of disease forecasting in management of plant diseases.
6. Principles of pest and disease management.
7. Pesticides-active ingredients their formulation, concentration and calculation.
8. New class of pesticide compounds including fermented products.
9. Plant Protection equipment their types and efficiency in practice.
10. Tools of Integrated Pest management (IPM) and Integrated Disease Management (IDM).
11. Package and practices for insect pest management in stored grains.

GROUP-D

1. Biotechnological approaches in pest management in Agriculture and Horticulture.
2. Improved Nursery techniques for raising Horticultural crops
3. Protected cultivation of different high value horticultural crops
4. Off-season vegetable cultivation in indoor and out door condition with special reference to Tomato, Cucumber and Capsicum
5. Concepts of Bio-intensive Integrated Pest Management.
6. Use of anti-feedants, repellants, pheromones in insect-pests management
7. Use of Botanical pesticides, microorganisms, bacteria, viruses and fungi and arthropod bio-control agents in crop pest and disease management

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15. ANIMAL HUSBANDRY AND VETERINARY SCIENCE (PAPER-I)

[Paper Code: AHV-I, Full Marks: 100, Time: 3 hours]

Group – A:

Animal Genetics and Breeding:

History of animal genetics, Inheritance of acquired characters, cell structure and functional organization, mitosis, meiosis, Chromosome aberrations, Cytoplasmic inheritance, Gene and its structure, DNA as a genetic material, Genetic code and protein synthesis, Recombinant DNA technology.

Mendel's laws, gene interaction, sex determination, sex linkages, heredity, quantitative inheritance, linkages and combination, different types of chromosomes, gene structure and functions, mutation, speciation and evolution, inbreeding and cross breeding, general and specific combining ability, heterosis, sire evolution, breeds of various important livestock species, breeding programmes, population statistics of livestock species. Population Genetics applied to Animal Breeding, quantitative v/s. qualitative traits, Hardy Weinberg Law; Population Vs. individual, Gene and genotypic frequency.

Group – B:

Animal Nutrition and Animal Physiology:

General nutrition, carbohydrates, proteins and fats their digestion and metabolism protein value of the feed measure of protein quality and its application, requirement of energy, protein, minerals (macro and micro), vitamins and additive for pigs and poultry, protein-energy interrelationship, comparative design of nutrients in various livestock species, partitioning of food energy within the animal, carbon – nitrogen balance.

Feed and animal body composition, function of water in body rumen digestion and metabolism, non-protein nitrogen metabolism in rumen, feeds and fodders, role of antibiotics, hormones and bio-stimulators, Conservation of fodders.

Swine Nutrition: Nutrient requirements, Creep, starter, grower and finisher rations, feeding of pigs for lean meat production, low cost rations for swine,
Poultry nutrition: Special features of poultry nutrition, nutrient requirements for meat and egg production, formulation of rations for different classes of layers and broilers.

Physiology of blood and its circulation, respiration, excretion, endocrine glands, digestion-control, motility and secretion of alimentary tract, gastric hormones, digestion and absorption in ruminants and monogastric animals, avian digestion. Chemical control of respiration, gaseous transport and exchange, high attitude living, physiology of work and exercise

Animal behaviour, ovarian function, estrus, ovulation, mechanism of sperm capacitating, sperm and ovum transport, female genital tract, fertilization, implantation, maintenance of pregnancy and physiology of placenta.

Artificial insemination collection, preservation, transport of semen, semen diluters, artificial insemination, embroyo transfer technology, preservation, transport and transplantation of zygotes, oocytes culture and in vitro fertilization.

Physiology of milk production, reproduction and digestion, Current status of hormonal control of mammary development, milk secretion and milk ejection, male and female reproductive organs, their components and functions. Digestive organs and their functions, Environmental Physiology, Physiological relations and their regulation, mechanisms of adaptation, environmental factors and regulatory mechanisms involved in animal behaviour, climatology its various parameters and their importance.

Group – C:

Livestock Production & Management, Livestock
Product Technology and Poultry Science:
General concepts of livestock production and management in Indian agro-climatic and socio-economic conditions, impacts of livestock farming in Indian Agriculture, concept of livestock housing, production and reproduction management of livestock species, lactation management, concept of machine milking, Commercial Dairy Farming: Comparison of dairy farming in India with advanced countries.

Poultry industry in India, random sample test, breeding programmes for broilers and layers. Legal and BES standards. Structure of eggs. Microbial spoilage. Preservation and maintenance. Marketing of poultry meat, eggs and products, Feeding and management of animals under drought, flood and other natural calamities.

Composition of milk, meat, fish, poultry and egg, technology or processing and preservation of livestock products, methods of processing and storage of meat. Meat products, eggs, poultry meat, food preservation, refrigeration freezing, freeze drying, dehydration, canning, radio pasteurization, chemical additives, curing, smoking.

Milk Technology: Organization of rural milk procurement, collection and transport of raw milk. Quality, testing and grading raw milk, Quality storage grades of whole milk, Skimmed milk and cream. Processing, packaging, storing, distributing, marketing defects.

Pasteurized milk, standardized milk, toned milk, double toned milk, sterilized milk, homogenized milk, reconstituted milk, recombined milk and flavoured milks. Preparation of cultured milks, cultures and their management, youghurt, Dahi, Lassi and Srikhand. Preparation of flavoured and sterlized milks. Legal standards, Sanitation requirement for clean and safe milk and for the milk plant equipment.

Group – D:

Veterinary Extension:

Basic philosophy, objectives, concept and principles of extension, different methods adopted to educate farmers under rural conditions. Animal husbandry programmes for rural development. Definition and concept of sociology, differences between rural, tribal and urban communities, social change, factors of changes. Principles and steps of extension education, community development – aims, objectives, organizational set up and concept evolution of extension in India, extension teaching method.

Role of livestock in Indian economy, health and socio-psychology of rural, semi-urban and urban society.

Identifying social taboos, social differences and obstacles in the way of organizing programmes. Concept of marketing, principles of co-operative societies, animal husbandry development planning and programme, key village scheme, ICDS, Goshala, Gosadan, role of gram panchayat in livestock production of rural economy. Data analysis, basics of statistics and computational techniques.

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16. ANIMAL HUSBANDRY AND VETERINARY SCIENCE (PAPER-II)

[Paper Code: AHV-II, Full Marks: 100, Time: 3 hours]

Group – A:
Veterinary Anatomy, Veterinary Surgery & Radiology,
Veterinary Gynaecology & Obstetrics

Structure of cell organelles, chromosome structure and functions, cell growth, division and differentiation and functions. Histology and physiology of mammalian organs and system, major sense organs and receptors; Exocrine and endocrine glands, hormone and their functions, blood composition and function. Homeostasis, osmoregulation and blood clotting.

General surgical principles and management of surgical cases. Types, administration and effect of anaesthesia. Principles and use of radiological techniques in the diagnosis of animal diseases. Anaesthesia-local, regional and general-preanaesthetic medication, Symptoms and surgical interference in fractures and dislocation, hernia, choking, abomassal displacement, caesarian operations, rumenotomy, castrations.

Estrus and estrus cycle in domestic animals, synchronization of estrus, fertilization, pregnancy diagnosis, parturition, management of post partum complications dystrokias and its management, fertility, infertility and its management.

Artificial Insemination: Components of semen, composition of spermatozoa, chemical and physical properties of ejaculated semen, factors affecting semen in vivo and in vitro. Factors affecting semen production and quality preservation, composition of diluents, sperm concentration, transport of diluted semen. Deep freezing techniques in domestic animals and poultry. Detection of estrus and time of insemination for better conception, Embryo transfer technology.

Group – B:

Veterinary Microbiology, Veterinary Public Health:

Classification and growth characteristics of bacteria, important bacterial diseases of livestock and poultry, general characters, classification of important fungi.

Nature of viruses, morphology and its characteristics, viral immunity, important viral diseases of livestock and poultry. Viral vaccines, Antigen and antibody, antibody formation, immunity, allergy, anaphylaxis hypersensitivity, immunoglobulin's complement system.

Zoonoses: Classification, definition; role of animals and birds in prevalence and transmission of zoonotic diseases-occupational zoonotic diseases. Important milk and meat born diseases, application of epidemiological measures in the study of diseases and disease control,
Epidemiological features of air, water and food borne infections.

Group – C:

Veterinary Pathology, Veterinary Parasitology:

Important viral, bacterial, protozoan diseases of livestock and poultry, etiology of diseases and concept, extrinsic and intrinsic factors, inflammation degeneration, necrosis, calcification, gangrene, death, atrophy, hypertrophy, benign and malignant tumours in domestic animals. Pathogenesis, symptoms, postmortum lesions, diagnosis, and control of infection diseases of cattle, pigs and poultry, horses, sheep and goats.

General classification, morphology, life cycle of important Ectoparasite and Endoparasite, important parasitic diseases (Helminthes, Protozoa, Arthropods) of veterinary importance with especial respect to epidemiology, symptoms pathogenesis, diagnosis, immunity and control.

Group – D:
Veterinary Pharmacology, Veterinary Medicine:

Source and nature of drugs, pharmacokinetics, chemotherapy, sulpha drugs, antibiotics, mechanism and problem of drug resistance. Drug allergy, important poisonous plants, toxicity of agro-chemicals and their detoxification, drug action on different body system. Drugs acting on fluids and electrolyte balance, drugs acting on Autonomic nervous system-Modern concepts of anaesthesia and dissociative anaesthetics, Autocoids, Antimicrobials and principles of chemotherapy in microbial injections.

Clinical examination and diagnosis, etiology, epidemiology, symptoms, diagnosis, prognosis, temperature and control of diseases affecting different body systems of various species of domestic animals, epidemiology, aims, objectives, ecological concepts and application.

Veterinary Jurisprudence: Rules and Regulations for improvement of animal quality and prevention of animal diseases-state and control Rules for prevention of animal and animal product borne diseases, S.P.C.A., Vetero-legal cases-certificates-Materials and Methods of collection of samples for vetero-legal investigation.

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17. CIVIL ENGINEERING (PAPER-I)
[*Paper Code: CVL-I, Full Marks: 100, Time: 3 hours*]

PART A
Engineering Mechanics:
Units and Dimensions, SI Units, Vectors, Concept of Force, Concept of particle and rigid body. Concurrent, Non Concurrent and parallel forces in a plane, moment of force, free body diagram, conditions of equilibrium, Principle of virtual work, equivalent force system.

First and Second Moment of area, Mass moment of Inertia. Static Friction.

Kinematics and Kinetics: Kinematics in Cartesian Co-ordinates, motion under uniform and non-uniform acceleration, motion under gravity. Kinetics of particle: Momentum and Energy principles, collision of elastic bodies, rotation of rigid bodies.

Solid Mechanics:
Bending moment and shear force in statically determinate beams. Simple stress and strain relationship: Stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle. Simple bending theory, flexural and shear stresses, unsymmetrical bending, shear centre. Thin walled pressure vessels, uniform torsion, Elastic stability of column, combined and direct bending stresses. Deflection of beams: Mohr's Moment area method, Conjugate beam method, unit load method, Elastic theories of failure.

Structural Mechanics:
Analysis of statically determinate trusses, arches, beams, cables and frames, displacements in statically determinate structures and analysis of statically indeterminate structures by force/ energy methods, analysis by displacement methods (slope deflection and moment distribution methods), influence lines for determinate and indeterminate structures. Basics of force and displacement matrix method for beams, plane frames (rigid and pin jointed), Plastic analysis of beams and simple frames, Elements of structural dynamics, free and forced vibration of single degree of freedom system, un-damped and damped system.

PART B
Design of concrete and Masonry Structures:
Concrete Technology- properties of concrete, basics of mix design. Concrete design- basic working stress and limit state design concepts, analysis of ultimate load capacity and design of R.C.C members (slabs, staircases, beams, lintels, columns, retaining walls) subjected to flexure, shear, compression and torsion. Basic elements of prestressed concrete, analysis of beam sections at transfer and service loads. Design of brick masonry as per IS Codes

Structural steel design:
Factors of safety and load factor, riveted, bolted and welded joints and connections. Analysis and design of tension and compression members, beams and beam columns, column bases. Connections- simple and eccentric, beam–column connections, plate girders and trusses. Battens and lacings.

PART C
Geotechnical Engineering
Soil Mechanics: Origin of soils, soil classification, three - phase system, fundamental definitions, relationship and interrelationships, permeability and seepage, effective stress principle, consolidation, compaction, shear strength.

Foundation Engineering: Sub-surface investigations- scope, drilling bore holes, sampling, penetration tests, plate load test. Earth pressure theories, effect of water table, layered soils. Stability of slopes- infinite slopes, finite slopes. Foundation types- foundation design requirements. Shallow foundations- bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays. Deep foundations – pile types, dynamic and static formulae, load capacity of piles in sands and clays, negative skin friction.

PART D
Building Materials:
Timber : Different types and species of structural timber, density-moisture relationship, strength in different directions, defects, influence of defects on permissible stress, preservation, dry and wet rots, codal provisions for design, Plywood.

Bricks: Types, Indian Standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength.

Cement: Compounds of, different types, setting times, strength.

Cement Mortar: Ingredients, proportions, water demand, mortars for plastering and masonry.

Concrete: Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, elasticity, non-destructive testing (NDT), mix design methods.

Paints & Varnishes: Classification and uses of common paints, distempers and varnishes.

Construction Planning & management:
Concreting Equipment: Weight Batcher, Mixer, vibrator, batching plant, concrete pump. Cranes, hoists, lifting equipment.

Earthwork Equipment: Power shovel, hoe, dozer, dumper, trailers and tractor, rollers, sheep foot rollers, pumps.

Construction, Planning and Management: Bar chart, linked bar chart, work-break down structures, Activity - on - arrow diagrams. Critical path, probabilistic activity durations; Event-based networks.

PERT network: Time-cost study, crashing; Resource allocation.

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18. CIVIL ENGINEERING (PAPER-II)
[*Paper Code: CVL-II, Full Marks: 100, Time: 3 hours*]

PART A
Surveying:
Importance of surveying, principles and classifications, mapping concepts, coordinate system, map projections, Surveying instruments, Total Station, GPS, measurements of distance and directions, leveling, theodolite traversing, plane table surveying, errors and adjustments, curves.

Disaster Management:
Concepts of disaster; Types of disaster - natural and manmade: Cyclone, flood, land slide, land subsidence, fire and earthquake. Issues and concern for various causes of disasters.
Disaster management, mitigation, and preparedness; Techniques of monitoring and design against the disasters.
Elements of Engineering Seismology: - Earthquake occurrence in the world causes of Earthquake, Plate tectonics, Earthquake mechanism, seismic zoning map of India and its use.
Earthquake phenomenon: - Focus, epicenter, seismic waves, magnitude, intensity scale its co-relation with ground acceleration. Guide lines on construction Earthquake resistant Houses, DO's and Don's for protection of life and property during disaster.
Remote-sensing and GIS applications in real time disaster monitoring, prevention and rehabilitation.

PART B
Water Resources Engineering:
Fluid Mechanics and Hydraulics: Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, flow in pipes, pipe networks. Concept of boundary layer and its growth. Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, flow measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modeling. Kinematics of flow, velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration. Crop water requirements. Design of: lined and unlined canals, waterways, head works, gravity dams and spillways. Design of weirs on permeable foundation. Types of irrigation system, irrigation methods. Water logging and drainage, cross drainages, sodic soils.

PART C
Transportation Engineering:
Highway Planning: Geometric design of highways, testing and specifications of paving materials, design of flexible and rigid pavements.

Traffic Engineering: Traffic characteristics, theory of traffic flow, intersection design, traffic signs and signal design, highway capacity.

Railway : Planning of railway systems, terminology and designs, relating to gauge, track, controls, transits, rolling stock, tractive power and track modernisation; Maintenance.

Harbours - layouts, shipping lanes, anchoring, location identification; Littoral transport with erosion and deposition; sounding methods; Dry and Wet docks, components and operational Tidal data and analyses.

Airports - layout and orientation; Runway and taxiway design and drainage management; Zoning laws; Visual aids and air traffic control; Helipads, hangers, service equipment.

PART D
Environmental Engineering:
Water Supply: Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water.

Sewage and sewerage treatment: Quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment Unit operations and unit processes of domestic wastewater, sludge disposal.

Water Pollution: Causes of water pollution, effects of human health and environment, water pollution measurement Techniques, control of water pollution.

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits. Pollution control acts. Legislation.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle energy recovery, treatment and disposal).

Noise Pollution: Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Land Pollution: Causes of land pollution and its effects.

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19. MECHANICAL ENGINEERING (PAPER-I)

[Paper Code: MEC-I, Full Marks: 100, Time: 3 hours]

Group – A
Theory of Machines & Machine Design:

Machine and Mechanism, Link, Kinematic Pair, Degrees of freedom, Kinematic chain, Various types of joints. Analysis of various mechanism with inversions, Velocity and acceleration in Mechanisms. Belt, rope & Chain drives, gears & gear train, Cams, Inertia forces in reciprocating mechanisms, Fly wheels, Governors, brakes & Dynamometers. Simple stress & strain, factor of safety, working stress, theories of failure ,Mohr's circle for simple & compress stress, combined bending moment & shear force diagram, Deflection of beam, Buckling of columns, combined bending & torsion, thick & thin cylinder, Design of helical spring, knuckle joint, cotter joint, flexible coupling, spur gear.

Group – B
Material Science:

Crystalline structure of solids; Concept of unit cell and space lattice; Miller indices; Crystal structure determination by X-ray diffraction , Mechanism of plastic deformation; Role of dislocation; Slip and Twinning; Strain hardening and recrystallisation; Elementary cause and treatment of creep fatigue and fracture. Phase and Phase equilibrium; Fe-C diagrams. Introduction and purpose of heat treatment; T-T-T curve and micro constituents in steel heat treatment process like hardening, tempering, normalizing, annealing, surface & chemical heat treatment.

Group – C
Manufacturing Science:

Casting, Welding, Metal Forming, Marchants's force analysis, Taylor's tool life equation, machinability and machining economics, rigid, small and flexible automation, NC, CNC. Recent machining methods. EDM,ECM and ultrasonic's. Application of lasers and plasmas, analysis of forming processes, Jigs, fixtures, tolls and gauges. Inspection of length, position profile and surface finish.

Group – D
Production Management:

Production, planning and control, Forecasting – moving average, exponential smoothing, Operations scheduling, aasembly line balancing, product development. Break even analysis, capacity planning. PERT and CPM. Control operations: Inventory control-ABC analysis EOQ model. Materials requirement planning. Job design, Job standards, work measurement, quality management – quality control. Operation Research: Linear programming – Graphical and simplex methods.

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20. MECHANICAL ENGINEERING (PAPER-II)

[Paper Code: MEC-II, Full Marks: 100, Time: 3 hours]

Group – A

Thermodynamics:
Basic concepts, System, Classification of system, Laws of thermodynamics, Properties of pure substances, Properties of gases & mixture of gases, Entropy, Availability & Irreversibility, Air standard cycles, Reciprocating air compressor. Analysis of steam and gas turbines, High pressures boilers, Conventional power system, draft and dust removal equipment, fuel and cooling water system, heat balance, station and plant heat rates.

Group – B

Heat Transfer, Refrigeration & Air-conditioning:
One and two dimensional heat conduction, Heat transfer from extended surfaces, heat transfer by forced and free convection, Heat exchangers, Laws of radiation, heat exchange between black and non-black bodies. Reversed Carnot Cycle, Vapor compression refrigeration system, Vapor absorption refrigeration system, Properties & choice of refrigerant, Different refrigeration equipment, Psychometry, Comfort air conditioning, Cooling load calculation, Air-conditioning plant layout.

Group – C

Fluid Mechanics & Turbomachines:
Basic concepts, Types of fluid, Continuity, momentum and Energy equation, Pascal's law, Buoyancy, Euler's and Bernoulli's equation, Laminar & turbulent flow, Hydraulic turbines; Pelton, Francis, and Kaplan turbines - Turbine efficiencies - Cavitation in turbines, Centrifugal pumps; theory, components, and characteristics - Cavitation - Axial flow pumps - Pump system matching.

Group – D

I.C. Engine & Combustion:
Introduction, classification of I.C.Engine, Engine component, The four stroke cycle, Valve timing, Valve and valve mechanism, Spark ignition four stroke cycle, carburetor, air-fuel mixture, compression ignition four stroke engine, fuel pump & injector, injection nozzle, comparison of four stroke and two stroke engine, combustion process in S.I and C.I engines, preignition and detonation in SI engine, diesel knock in C.I engine.

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21. ELECTRICAL ENGINEERING (PAPER-I)
[*Paper Code: ELC-I, Full Marks: 100, Time: 3 hours*]

Group A :
Electrical Circuits:
Circuit's elements. Kirchhoff 's Laws. Mesh and nodal analysis. Network Theorems and their applications in AC & DC Circuits. Natural response and forced response. Transient response and steady state response for arbitrary inputs and different wave forms. Properties of networks in terms of poles and zeros. Transfer function. Single phase &Three-phase circuits. Two-port networks. Elements of two element network synthesis. PR of Network functions.

Group B :
Electrical Engineering Materials & Fields theory :
Band Theory, Conductors, Semiconductors (Direct band gap & Indirect band gap) and Insulators. Super-conductivity. Insulators for electrical and electronic applications. Magnetic materials. Ferro and ferri magnetism. Ceramics: Properties and applications. Hall effect and its applications. Special semi-conductors.
Electric and magnetic fields. Gauss' Law and Ampere's Law. Fields in dielectrics, conductors and magnetic materials. Maxwell's equations. Time varying fields. Plane Wave propagation in di-electric and conducting media. Transmission lines, boundary conditions, wave propagation through rectangular and cylindrical waveguides.

Group C :
Measurements and Instrumentation:
Units and Standards. Error analysis, measurement of current. Voltage, power, Power-factor and energy. Indicating instruments. Measurement of resistance, inductance, capacitance and frequency. Bridge measurements. Electronic measuring instruments. Digital voltmeter and frequency counter. Transducers and their applications to the measurement of non-electrical quantities like temperature, pressure, level, flow-rate displacement, acceleration, noise level, etc. A/D , D/A Converters and Data acquisition systems.

Group D :
Control Systems:
Mathematical modeling of physical systems. Block diagrams & signal flow graphs and their reduction. Time domain and frequency domain analysis of linear dynamical system. Errors for different types of inputs and stability criteria for feedback systems.

Stability analysis using Routh-Hurwitz Criteria, Nyquist plot and Bode plot. Root locus and Nicols chart and the estimation of gain and phase margin. Basic concepts of compensator design. State variable analysis and its use in system modeling and design.

Sampled data system and performance of such a system with the samples in the error channel. Stability of sampled data system. Controllability & Observability of time invariant and sampled data systems.

Elements of non-linear control analysis. Control system components; electromechanical, hydraulic, pneumatic components.

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22. ELECTRICAL ENGINEERING (PAPER-II)
[*Paper Code: ELC-II, Full Marks: 100, Time: 3 hours*]

Group A:
Electrical Machines:
Magnetic Circuits-Analysis and Design of Power transformers. Construction and testing, Equivalent circuits, Losses and efficiency, Regulation. Auto-transformer, 3-phase transformer, Parallel operation.

Basic concepts in rotating machines: EMF, torque, basic machine types: Construction and operation, leakage, losses and efficiency.

D.C. Machines: Construction, Excitation methods, Circuit models. Armature reaction and commutation, Characteristics and performance analysis. Generators and motors. Starting and speed control. Testing, Losses and efficiency.

Synchronous Machines: Construction, Circuit model, Operating characteristics and performance analysis. Synchronous reactance, Efficiency, Voltage regulation. Salient-pole machine: Parallel operation. Hunting, Short circuit transients.

Induction Machines: Construction, Principle of operation, Rotating fields, Characteristics and performance analysis. Determination of circuit model and Circle diagram. Starting and speed control.

Fractional KW motors: Single-phase synchronous and induction motors.
Special motors: servo motors, stepper motors, universal motor and repulsion motors.

Group B:
Power systems:

Types of Power Stations, Hydro, Thermal and Nuclear Stations. Pumped storage plants. Economics and operating factors.

Power transmission lines. Modeling and performance characteristics. Voltage control, Active and reactive power control, Load flow studies. Optimal power system operation. Load frequency control. Symmetrical short circuit analysis. Z-Bus formulation. Symmetrical Components. Per Unit representation. Fault analysis. Transient and steady-state stability of power systems. Equal area criterion.

Power system Transients. Power system Protection: Analog and Digital, Circuit breakers, Relays, HVDC transmission.

Group C:
Analog & Digital Electronics, Microprocessor & Microcontroller:

Semiconductor device physics, PN junctions and transistors, circuit models and parameters, FET, Zener, tunnel, Schottky, photo diodes and their applications, rectifier circuits, voltage regulators and multipliers, switching behavior of diodes and transistors.

Small signal amplifiers, biasing circuits, frequency response and improvement, multi-stage amplifiers and feed-back amplifiers, D.C. amplifiers, Oscillators. Large signal amplifiers, coupling methods, push pull amplifiers, operational amplifiers, and wave shaping circuits. Multi-vibrators and flip-flops and their applications. Digital logic gate families, universal gates combinational circuits for arithmetic and logic operation, sequential logic circuits. Counters, registers, RAMs and ROMs.

Intel 8085 Micro-processor architecture Instruction set and simple assembly language programming. Interfacing for memory and I/O. Introduction to 8051 micro controller, Instruction sets and its interfacing techniques.

Group D:
Communication Systems and Power Electronics:
Types of modulation; AM, FM and PM. Demodulators. Noise and bandwidth considerations. Digital communication systems. Pulse code modulation and demodulation. Elements of sound and vision broadcasting. Carrier communication. Frequency division and time division multiplexing, Telemetry system in power engineering.

Power semi-conductor devices. Thyristor. Power transistor, GTOs , MOS-FETs and IGBT. Characteristics and operation. AC to AC Converters , AC to DC Converters; DC to DC Converters; AC regulators. Thyristor controlled reactors, switched capacitor networks. Inverters: Single-phase and 3-phase. Pulse width modulation. Sinusoidal modulation with uniform sampling. Switched mode power supplies. AC and DC Drives – different techniques.

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