

PHYSICAL SCIENCES

Candidate must attempt two sections.

Section –A is compulsory, and candidate can choose any one section B or C or D

SECTION-A MATHEMATICS

Unit-I

REAL NUMBERS SYSTEM, SEQUENCES AND SERIES: Field axioms, Dedekind's axiom, Bolzano's theorem, Countability of sets, Sequences and their limits, Subsequences, Convergence and Divergence of sequences, Limit of a sequence, Cauchy sequences, Cauchy general principle of convergence, Definition of infinite series, necessary condition for convergence, Comparison test, nth root test, Ratio test, Integral test, Alternating series, Leibnitz test, Absolute convergence and Conditional convergence

Unit-II

VECTOR CALCULUS

Vector differentiation, Ordinary derivatives of vectors, Space curves, Continuity, Differentiability, Gradient, Divergence, Curl operators, Formulae involving these operators.

Vector integration, theorems of Gauss and Stokes, Green's theorem in plane and applications of these theorems.

Unit-III

GROUPS

Groups, subgroups and cyclic groups, Permutations, Isomorphism-definition and elementary properties, Cayley's theorem, Groups of Cosets, Normal subgroups-factor groups, the fundamental theorem of homomorphisms

Unit-IV

DIFFERENTIAL EQUATIONS

Linear differential equations, Exact differential equations, Simultaneous differential equations, orthogonal trajectories, equations solvable for p, x, y , solution of homogeneous linear differential equations of order n with constant coefficients, method of variation of parameters

Unit-V

MATRICES

Determinants, properties of determinants, elementary matrix operations and elementary matrices, the rank of a matrix and matrix inverse, system of linear equations, eigenvalues and eigenvectors, diagonalization, Cayley-Hamilton theorem

SECTION-B STATISTICS

Unit-I

Measures of Central Tendency - Mean, Median, Mode, Geometric Mean and Harmonic Mean, Measures of dispersion: Range, Quartile Deviation, Mean Deviation and Standard Deviation, Central and Non-Central moments. Skewness and kurtosis.

Unit-II

Basic Concepts of Probability, Conditional Probability and independence of events, addition and multiplication theorems of probability, Boole's inequality and Bayes's theorems, discrete and continuous random variables, Probability mass function, Probability density function, Distribution function and its properties, Bivariate random variables, joint, marginal and conditional distributions.

Unit-III

Mathematical expectation (ME) of a random variable and function of a random variable, Moments and covariance, Moment generating function its properties, Chebyshev and Cauchy - Schwartz inequalities, Discrete Distributions: Binomial, Poisson distributions and geometric distributions Continuous Distributions: Rectangular, Exponential, Normal Distribution, Correlation and Regression.

Unit -IV

Exact sampling distributions: Concept of population, Parameter, random sample, statistic, sampling distribution, standard error, chi square, t and F distributions.

Concepts of Statistical hypothesis: Null and alternative hypothesis, critical region, two types of errors, level of significance, power of a test, 1 tailed, 2 tailed tests, Neyman - Pearson's lemma.

Unit-V

Large Sample Tests: Large sample tests for single mean, two means, Single proportion, Two proportions, Standard Deviation of single and double samples and Fisher's Z transformation.

SECTION- C

PHYSICS

Unit-1:

Mechanics of rigid bodies: Definition of Rigid body, rotational kinematic relations, equation of motion for a rotating body, angular momentum and inertial tensor. Eulers equation, precession of a top, Gyroscope, precession of the equinoxes

Central forces: Central forces – definition and examples, conservative nature of central forces, conservative force as a negative gradient of potential energy, equation of motion under a central force, gravitational potential and gravitational field, motion under inverse square law, derivation of Kepler's laws, Coriolis force and its expressions

Unit -2:

Thermodynamics: Introduction – Reversible and irreversible processes – Carnot's engine and its efficiency – Carnot's theorem – Second law of thermodynamics, Kelvin's and Clausius statements – Thermodynamic scale of temperature – Entropy, physical significance – Change in entropy in reversible and irreversible processes – Entropy and disorder – Entropy of universe – Temperature- Entropy (T-S) diagram – Change of entropy of a perfect gas-change of entropy when ice changes into steam.

Unit-3:

Optics: Principle of superposition – coherence – temporal coherence and spatial coherence – conditions for Interference of light. Interference by division of wave front. Interference by division of amplitude. Introduction – Distinction between Fresnel and Fraunhofer diffraction. Resolving Power of grating. Methods of Polarization, Polarization by reflection, refraction, Double refraction, selective absorption, scattering of light – Brewsters law – Malus law – Nicol prism polarizer and analyzer.

Laser & Fiber Optics: Lasers: Introduction – Spontaneous emission – Stimulated emission – Population inversion. Laser principle – Einstein coefficients – Types of Lasers – He-Ne laser – Ruby laser – Applications of lasers. Fiber Optics : Introduction – Optical fibers – Types of optical fibers – Step and graded index

Unit-4:

Dielectrics: An atomic view of dielectrics, potential energy of a dipole in an electric field. Polarization and charge density, Gauss's law for dielectric medium– Relation between D,E, and P. Dielectric constant, susceptibility and relation between them. Boundary conditions at the dielectric surface. Electric fields in cavities of a dielectric-needle shaped cavity and disc shaped cavity.

Magnetic Materials: Dia, Para, Ferromagnetic Materials, Classical Langevin Theory of Paramagnetism, CurieWeiss's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains-

Unit-5:

Moving charge in electric and magnetic field: Hall effect, cyclotron, synchrocyclotron and synchrotron – force on a current carrying conductor placed in a magnetic field, force and torque on a current loop, Biot –Savart's law and calculation of B due to long straight wire, a circular current loop and solenoid.

Electromagnetic induction: Faraday's law –Lenz's law – expression for induced emf – time varying magnetic fields – Betatron –Ballistic galvanometer – theory – damping correction – self and mutual inductance, coefficient of coupling, calculation of self inductance of a long solenoid – toroid – energy stored in magnetic field – transformer – Construction, working, energy losses and efficiency.

SECTION- D

ELECTRONICS

Unit-1:

AC Fundamentals: The Sine wave –Average and RMS values–Phasor diagram – Complex impedance, *Network theorems (DC and AC):* Superposition Theorem–Thevenin’s Theorem–Norton’s Theorem–Maximum power transfer Theorem–Reciprocity Theorem – Application to simple networks.

RC and RL Circuits: Transient response of RL and RC circuits with step input– time constants. RC and RL circuits –Low pass and High pass filter frequency response - Passive differentiating and integrating circuits. **Resonance:** Series resonance and parallel resonance RLC circuits – Resonant frequency – Q factor – Band width – Selectivity.

Unit-2:

PN Junction: Depletion region – Junction capacitance – Diode equation–construction, working, V-I characteristics and simple applications of i) Junction diode ii) Zener diode iii) Tunnel diode and iv) varactor diode

Bipolar Junction Transistor (BJT): PNP and NPN transistors–current components in BJT – BJT static characteristics (Input and Output). CB, CC, CE configurations (cut off, active, and saturation regions) **Field Effect Transistor (FET):** Structure and working of JFET and MOSFET – output and transfer characteristics. Advantages of FET over transistor

Unit-3:

Operational Amplifiers: Differential amplifier- Ideal characteristics of Op-Amp- Op-Amp parameters- Input resistance- Output resistance- Common mode rejection ratio (CMMR)- Slew rate- Offset voltages – Input bias current- Basic Op-Amp circuits- Inverting Op-Amp- Virtual ground- Non-inverting Op-Amp-**Applications of Op-Amps:** Summing amplifier- subtractor- Voltage follower- Integrator -Differentiator - Comparator.

Communications: Need for modulation-Types of modulation- Amplitude modulation-side bands- modulation index- diode modulator- Demodulation. Frequency modulation, detection of FM- Advantages of FM over AM

Unit-4:

Digital Electronics: Introduction to number systems, Logic gates and truth tables RTL, DTL, ECL, TTL and CMOS logic families. NAND and NOR gates. Boolean algebra, De Morgan’s Theorems, Karnaugh Maps – Sum of products (SOP) and Product of sums (POS)

Combinational and Sequential circuits: Multiplexer and De-Multiplexer – Decoder, Half adder and Full adder circuits. Flip flops – RS, D and JK - Semiconductor memories –Synchronous and asynchronous binary counters, Up/Down counters- Decade counter (7490)

Unit-5:

Introduction to Microcomputer and Microprocessor: Intel 8085 Microprocessor – central processing unit CPU – arithmetic and logic unit ALU – timing and control unit – register organization – address, data and control buses- pin configuration of 8085 and its description. Timing diagrams. Instruction set of 8085, addressing modes.

MODEL QUESTIONS

1. The derivative of a differential even function is []
a) odd function (b) even function (c) constant function (d) None of these
2. The system of equations
 $2x + 3y + 4z + 1 = 0, 2x + 6y + 8z + 3 = 0, x + y + z + 1 = 0$ has []
(a) no solution (b) a unique solution
(c) infinite number of solutions (d) none of these
3. The probability that a non-leap year should have 53 Tuesdays is []
a) $1/7$ (b) $2/7$ (c) $3/7$ (d) $4/7$
4. The mean and variance of Normal Distribution []
a) Are same b) cannot be same c) are some times equal d) are equal in the limiting case as $n \rightarrow \infty$.
5. If A and B Mutually exclusive events, then []
a) $P(A \cup B) = P(A) \cdot P(B)$ b) $P(A \cup B) = P(A) + P(B)$ c) $P(A \cup B) = 0$ d) None of these.
6. If $\text{Var}(X)=1$, then $\text{Var}(2x+3)$ is []
a) 5 b) 13 c) 4 d) 0
7. Hall effect determines
(A) Sign of charges (B) Voltage (C) Current (D) loss of energy
8. Double refraction occurs due to
(A) Change in media (B) Change in frequency
(C) Refraction (D) None of these
9. In an RL circuit the current and voltage relationship of phase
(A) Lead (B) Lag (C) In phase (D) None
10. CMRR of ideal Op-Amp is
(A) Zero (B) Infinite (C) One (D) None of these
