A

24124 **120 MINUTES**

1. If the function F(t)=1, its Laplace transform f(s) is given by:
   A) $\frac{1}{s^2}$ B) $\frac{n!}{s^{n+1}}$ C) S^2 D) $\frac{1}{s}$

2. The degree of differential equation $\left(\frac{d^2y}{dx^2}\right)^2 = \left(1+\frac{dy}{dx}\right)^{\frac{1}{2}}$ is:
   A) 2 B) 4 C) $\frac{1}{2}$ D) 1

3. The diagonal elements of a diagonal matrix are 5, 1 and 3. The eigen values of the matrix are:
   A) 7, 3, 4 B) $\frac{1}{5}, 1, \frac{1}{3}$ C) 5, 1, 3 D) $\frac{5}{2}, \frac{1}{2}, \frac{3}{2}$

4. The path of extremum distance between any two points in Riemannian space is:
   A) Straight line B) Elliptical C) Cycloid D) Geodesic

5. If λ is the trace of the matrix A and the matrix A undergoes similarity transformation to generate matrix B. The trace of B is:
   A) $\frac{1}{\lambda}$ B) λ C) λ^2 D) $\frac{1}{\lambda^2}$

6. For a complex function $f(z) = U(x,y) + iV(x,y)$, Cauchy- Riemann equation in cartesian form is:
   A) $\frac{\partial U}{\partial x} = \frac{\partial V}{\partial y}, \frac{\partial V}{\partial x} = -\frac{\partial U}{\partial y}$ B) $\frac{\partial U}{\partial x} = -\frac{\partial V}{\partial y}, \frac{\partial V}{\partial x} = \frac{\partial U}{\partial y}$
   C) $\frac{\partial U}{\partial x} = \frac{\partial V}{\partial y}, \frac{\partial V}{\partial x} = \frac{\partial U}{\partial y}$ D) $\frac{\partial U}{\partial x} = -\frac{\partial V}{\partial y}, \frac{\partial V}{\partial x} = -\frac{\partial U}{\partial y}$

7. The minimum drain-source voltage at which drain current becomes constant is called:
   A) Knee voltage B) Breakdown voltage
   C) Pinch off voltage D) None of these

8. The Boolean expression A+AB is equal to:
   A) 1 B) 0 C) A D) B

9. The residue of complex function $\frac{z^3-z^2+1}{z^3}$ at infinity is:
   A) 0 B) 1 C) ∞ D) 2

10. If $J_n(x)$ is the Bessel's function of first kind, its generating function is given by:

A) $\exp\frac{x}{2}\left(t-\frac{1}{t}\right)$ B) $\exp\frac{x}{2}\left(1-\frac{1}{t}\right)$

C) $\exp\frac{x}{2}(1-t)^{-1}$ D) $\exp\frac{x}{2}\left(1-\frac{1}{t}\right)^{-1}$

11. For Dirac delta function, $\int_{-\infty}^{+\infty} x\delta(x-a)\,dx$ is:

A) $\frac{1}{a}$ B) $\frac{1}{a^2}$ C) a D) a^2

12. The expression for generalized force is:

A) $Q_j = \sum_j \vec{F}_j . \frac{\partial \vec{r}_j}{\partial q_k}$ B) $Q_k = \sum_j \vec{F}_j . \frac{\partial \vec{r}_j}{\partial q_k}$

C) $Q_k = \sum_j \vec{F}_k . \delta \vec{r}_k$ D) $Q_k = \sum_j \vec{F}_k . \delta \vec{r}_k$

13. The quantity which remains invariant under Galilean transformation is:

A) Velocity B) Displacement
C) Acceleration D) Momentum

14. A particle is moving with a speed comparable to speed of light (c). At what speed the mass of the body becomes 25% greater than its rest mass.

A) 0.6c B) 0.553c C) 0.25 c D) 1.25c

15. A cylinder rolls without slipping along an inclined plane. The number of degrees of freedom is:

A) 4 B) 3 C) 2 D) 1

16. If 'm' is the mass of electron, the reduced mass of positronium is:

A) $\frac{m}{4}$ B) $\frac{m}{2}$ C) $\frac{m}{3}$ D) m

17. If l is the length of the simple pendulum, θ is the angle of suspension and m is the mass of the bob, the Lagrangian of simple pendulum is:

A) $\frac{1}{2}ml\dot{\theta}^2 - mgl(1-\cos\theta)$ B) $ml\dot{\theta}^2 - mgl(1-\cos\theta)$

C) $\frac{1}{2}ml\dot{\theta}^2 - mgl(1-\sin\theta)$ D) $\frac{1}{2}ml^2\dot{\theta}^2 - mgl(1-\cos\theta)$

18. If q_i is the generalized coordinate and L is the Lagrangian, the generalized momentum is given by:

A) $\frac{\partial L}{\partial q_i}$ B) $\frac{\partial L}{\partial \dot{q}_i}$ C) $\frac{\partial L}{\partial p_i}$ D) $\frac{\partial L}{\partial \dot{p}_i}$

19. Hamilton's canonical equations of motion are given by:

A) $\dot{q}_k = \frac{\partial H}{\partial p_k};\ \dot{p}_k = \frac{\partial H}{\partial q_k}$ B) $\dot{q}_k = \frac{\partial H}{\partial \dot{p}_k};\ p_k = \frac{\partial H}{\partial \dot{q}_k}$

C) $\dot{q}_k = -\frac{\partial H}{\partial p_k};\ \dot{p}_k = \frac{\partial H}{\partial q_k}$ D) $\dot{q}_k = \frac{\partial H}{\partial p_k};\ \dot{p}_k = -\frac{\partial H}{\partial q_k}$

20. Conservation of linear momentum is the consequence of:

A) Homogeneity of time B) Isotropy of space
C) Homogeneity of space D) None of the above

21. If the generalized coordinate q_k is cyclic, then:

A) $\frac{\partial L}{\partial \dot{p}_k} = 0\ and\ \frac{\partial L}{\partial \dot{q}_k} = 0$

B) $\frac{\partial L}{\partial q_k} = 0\ and\ p_k = a\ constant$

C) $\frac{\partial L}{\partial \dot{p}_k} = 0\ and\ p_k = a\ constant$

D) $\frac{\partial L}{\partial \dot{q}_k} = 0\ and\ p_k \neq a\ constant$

22. The Hamiltonian for charged particle in electromagnetic field:

A) $H = \frac{1}{2m}\left(\vec{p} - q\vec{A}\right)^2 + q\phi$

B) $H = \frac{1}{2m}\left(\vec{p} + q\vec{A}\right)^2 + q\phi$

C) $H = \frac{1}{2m}\left(\vec{p} + q\vec{A}\right)^2 - q\phi$

D) $H = \frac{1}{2m}\left(\vec{p} - q\vec{A}\right)^2 - q\phi$

23. If F_k, $k=1,2,3....2n$ are two independent functions such that F_k is a function of $2n$ coordinates $q_1,q_2,q_3....q_n$, $p_1,p_2,p_3....p_n$. Then, relation between Lagrange and Poisson brackets are:

A) $\sum_{k=1}^{2n}\left(\{F_k,F_i\} - [F_k,F_j]\right) = \delta_{ij}$ B) $\{F_k,F_i\} = -[F_k,F_j]$

C) $\sum_{k=1}^{2n}\{F_k,F_i\}[F_k,F_j] = \delta_{ij}$ D) $\sum_{k=1}^{2n}\{F_k,F_i\} = \sum_{k=1}^{2n}[F_k,F_j]$

24. For the wavefunctions ψ_i and ψ_j, the orthonormality condition is given by:

A) $\int_{-\infty}^{+\infty} \psi_i^* \psi_j dx = 1$ B) $\int_{-\infty}^{+\infty} \psi_i^* \psi_j dx = 0$

C) $\int_{-\infty}^{+\infty} \psi_i^* \psi_j dx = \delta_{ij}$ D) None of these

25. The hydrogen is in p-state. The values of magnetic quantum number m_l for this state are:

A) 0, 1 B) -2, -1, 0, 1, 2

C) ± 1 D) -1, 0, 1

26. Example of Hermitian operator is:

A) $\frac{d}{dx}$ B) $\left(\frac{d}{dx}\right)^2$ C) $\left(\frac{d}{dx}\right)^3$ D) $\frac{d^2}{dx^2}$

27. If $a\dagger$ and a are creation and annihilation operator and $|n>$ is the state function of the harmonic oscillator, the value of $<0|aa\dagger a\dagger|0>$ is:

A) 2 B) 1 C) 0 D) -1

28. The WKB approximation is more valid for systems having:

A) Heavy mass, high energy and slowly varying potential
B) Low mass, low energy and slowly varying potential
C) Heavy mass, low energy and slowly varying potential
D) Heavy mass, high energy and abruptly varying potential

29. Fermi Golden rule is related to:

A) Emission from one discrete level to another
B) Absorption between two discrete levels
C) Transition to continuum state
D) Not related to either absorption or emission

30. Klein Gorden equation is given by:

A) $\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\psi(\vec{r},t) = m^2c^2\psi(\vec{r},t)$

B) $\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\psi(\vec{r},t) = \frac{m^2c^2}{\hbar^2}\psi(\vec{r},t)$

C) $\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\psi(\vec{r},t) = \frac{\hbar^2}{m^2c^2}\psi(\vec{r},t)$

D) $\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\psi(\vec{r},t) = \frac{\hbar}{mc}\psi(\vec{r},t)$

31. Pauli's spin matrices are
A) Commuting 2x2 matrices
B) Anticommuting 3x3 matrices
C) Anticommuting 2x2 matrices
D) Commuting 3x3 matrices

32. A bomb of mass 20kg at rest is exploded into two fragments, each of mass 12kg and 8kg. The former has velocity $4ms^{-1}$. The kinetic energy of the latter is:
A) 225 J B) 169 J C) 196 J D) 144 J

33. A uniform chain of mass *m* and length *l* is placed on a smooth table. One fourth of the length of the chain is hanging over the edge. The work needed to pull the chain onto the table is:

A) $\frac{mgl}{32}$ B) $\frac{mgl}{4}$ C) mgl D) $4mgl$

34. In a clock, the ratio of angular velocity of minute hand to the angular velocity of hour hand is:
A) 12 B) 1/12 C) 6 D) 1/6

35. For a body centered cubic lattice, the coordination number is:
A) 4 B) 6 C) 8 D) 12

36. If *a* is the lattice parameter, the interplanar spacing for (100) planes of cubic lattice is:

A) $\frac{a}{\sqrt{2}}$ B) $a\sqrt{2}$ C) a D) 2a

37. Crystal plane, parallel to z-axis, cuts the x and y axes creating intercepts 2 and 3 respectively. The Miller indices is:
A) $(3, 2, \infty)$ B) $(\frac{1}{2}, \frac{1}{3}, \infty)$ C) (2, 3, 0) D) (3, 2, 0)

38. For the first Brillouin zone of linear lattice with lattice parameter a, the range of k is given by:

A) $-\frac{\pi}{a} \leq k \leq \frac{\pi}{a}$ B) $-\frac{2\pi}{a} \leq k \leq \frac{2\pi}{a}$

C) $0 \leq k \leq 2\pi a$ D) $0 \leq k \leq \frac{2\pi}{a}$

39. If $\vec{a}$ is the primitive translation vector of the direct lattice and $\vec{a}^*$ is the reciprocal lattice vector, $\vec{a}.\vec{a}^*$ is:

A) $\frac{\pi}{2}$ B) π C) 2π D) 0

40. The reciprocal lattice of BCC Bravais lattice is:

A) BCC lattice B) FCC lattice

C) Simple Cubic D) Hexagonal

41. The variation of Fermi energy with temperature is:

A) $E_F = E_{F0}\left(1 + \frac{\pi}{12}\left(\frac{kT}{E_{F0}}\right)^2\right)$ B) $E_F = E_{F0}\left(1 + \frac{\pi^2}{12}\left(\frac{kT}{E_{F0}}\right)^2\right)$

C) $E_F = E_{F0}\left(1 - \frac{\pi^2}{12}\left(\frac{kT}{E_{F0}}\right)^2\right)$ D) $E_F = E_{F0}\left(1 - \frac{\pi}{12}\left(\frac{kT}{E_{F0}}\right)^2\right)$

42. $U_k(\mathbf{r})$ is a function which possesses the periodicity of the lattice. The wave function of electron moving in periodic potential is given by:

A) $\psi_k(\vec{r}) = u_k(\vec{r})$ B) $\psi_k(\vec{r}) = u_k(\vec{r} + \lambda)$

C) $\psi_k(\vec{r}) = u_k(\vec{r})\exp -(\vec{k}.\vec{r})$ D) $\psi_k(\vec{r}) = u_k(\vec{r})\exp i(\vec{k}.\vec{r})$

43. Langevin function is given by:

A) $L(x) = \coth x - \frac{1}{x}$ B) $L(x) = \frac{1}{\coth x} - \frac{1}{x}$

C) $L(x) = \coth x + \frac{1}{x}$ D) $L(x) = \tanh x - \frac{1}{x}$

44. The effective mass of Bloch electron as a function of k is given by:

A) $\frac{h^2}{\left(\frac{d^2E}{dk^2}\right)}$ B) $\frac{h^2}{4\pi^2\left(\frac{d^2E}{dk^2}\right)}$ C) $\frac{h^2}{4\pi^2}\left(\frac{d^2E}{dk^2}\right)$ D) Δmc

45. For spherically symmetric charge distribution, nuclear quadrupole moment is

A) Infinity B) Less than zero

C) Greater than zero D) Zero

46. The radius of ^{64}Cu nucleus is 4.8 fermi. The radius of ^{27}Al is:

A) 3.6 fermi B) 2.7 fermi C) 4.8 fermi D) 6.4 fermi

47. The total nuclear angular momentum quantum number *i* (nuclear spin) for $^{13}_{6}C$ is:

A) Half integer B) Integer C) Zero D) Negative

48. Half-life of a radioactive material is 10 days. After 50 days, the fraction remaining undecayed:

A) $\frac{1}{32}$ B) $\frac{1}{16}$ C) $\frac{1}{8}$ D) $\frac{1}{4}$

49. Baryon number of antineutrino is:
A) -1 B) 0 C) +1 D) ± 1

50. For an electron revolving round the nucleus, gyromagnetic ratio is:
A) $\frac{e}{mc}$ B) $\frac{e}{2mc}$ C) $\frac{2e}{mc}$ D) $\eta = \frac{T_1}{T_2}$

51. A vibration is Raman active, if it is accompanied by change in:
A) Dipole moment of molecule
B) Polarizability of molecule
C) Magnetic moment of the material
D) None of these

52. In rotation vibration spectra of diatomic molecule, the lines corresponding to $\Delta J = -1$ are called:
A) P branch B) Q branch
C) R branch D) None of these

53. The nucleus which gives NMR spectrum is:
A) ${}^{15}_{7}N$ B) ${}^{16}_{8}O$ C) ${}^{12}_{6}C$ D) ${}^{4}_{2}He$

54. Which of the following molecules does **not** exhibit rotational spectrum?
A) HBr B) N_2 C) HCl D) CO

55. The hydrogen atom is in p-state. The values of j are:
A) $\frac{3}{2}, \frac{1}{2}$ B) $-\frac{1}{2}, \frac{1}{2}$ C) $-\frac{1}{2}, 0, \frac{1}{2}$ D) $0, \frac{1}{2}$

56. Microcanonical ensemble is the collection of large number of systems having same:
A) Energy, volume and temperature
B) Energy, volume and number of particles
C) Temperature, volume and number of particles
D) Temperature, volume and chemical potential

57. For gas molecules, the average speed is given by:
A) $\sqrt{\frac{2kT}{m}}$ B) $\sqrt{\frac{8kT}{\pi m}}$ C) $\sqrt{\frac{3kT}{m}}$ D) None of these

58. For a good conductor, skin depth δ is related to frequency ω. That is, δ is proportional to:
A) $\omega^{1/2}$ B) $\omega^{-1/2}$ C) ω D) ω^2

59. Energy of electromagnetic wave in vacuum is:

A) $\frac{1}{2}\varepsilon_0 E^2 + \frac{B^2}{2\mu_0}$ B) $\frac{E^2}{2\varepsilon_0} + \frac{B^2}{2\mu_0}$ C) $\frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2}\mu_0 B^2$ D) $E^2 + B^2$

60. The maximum current flowing through 10k resistor with power rating 1W:
A) 1mA B) 10mA C) 100mA D) 1 A

61. If all the eigen values of a matrix are real, then the matrix must be:
A) Symmetric B) Skew-symmetric
C) Diagonalizable D) Invertible

62. The Dirichlet conditions are requirements that a function must satisfy to ensure the convergence of its Fourier series. Which of the following is one of the Dirichlet conditions?
A) The function must be bounded on the entire real line.
B) The function must be differentiable everywhere.
C) The function must have only odd-order derivatives.
D) The function must have a finite number of discontinuities in any given period.

63. Evaluate the expression $\frac{2+3i}{1-2i}$:

A) *(-4-7i)/5* B) *(-4+7i)/5* C) *(4+7i)/5* D) *(4-7i)/5*

64. Which of the following is a Taylor series centered at x = 0?
A) Maclaurin series B) Power series
C) Polynomial series D) Exponential series

65. According to the Residue Theorem in complex analysis, what is the value of the integral of a function around a closed contour enclosing all its poles?
A) Zero
B) Equal to the sum of the residues inside the contour
C) Undefined
D) Equal to the value of the function at the origin

66. In a three-dimensional space, the moment of inertia tensor typically have ---- component/s.
A) 1 B) 2 C) 3 D) 6

67. The Hamiltonian of a closed system is conserved over time. This statement is a consequence of the fundamental principle of conservation of -----.
A) Energy B) Momentum
C) Angular momentum D) Charge

68. In a system with two generalized coordinates q_1 and q_2, if q_1 is cyclic, what is the implication for the corresponding conjugate momentum p_1?
A) p_1 must be constant throughout the motion
B) $p_1$must be a periodic function of time.
C) $p_1$must be zero
D) p_1 must be equal to q_1

69. Which of the following conditions must be satisfied for a transformation to be canonical?
A) It preserves the Hamiltonian.
B) It changes the total energy of the system.
C) It modifies the angular momentum.
D) It alters the total momentum.

70. ------ transformation is commonly used in the Hamilton-Jacobi theory to simplify the Hamiltonian equations.
A) Canonical B) Legendre C) Fourier D) Unitary

71. A particle is constrained in a one-dimensional box of length 2a with potential $\boldsymbol{V(x) = \infty\,; x \leq -a\,, x > a}$ *and* $\boldsymbol{V(x) = 0\,; -a \leq x \leq a}$
Energy difference between level n = 3 and n = 2 is:

A) $\frac{5h^2}{8ma^2}$ B) $\frac{9h^2}{8ma^2}$ C) $\frac{9h^2}{32ma^2}$ D) $\frac{5h^2}{32ma^2}$

72. Which of the following expressions represents the Hermitian conjugate (adjoint) of a bra vector ⟨ψ|?
A) |ψ⟩ B) ⟨ψ|† C) ⟨ψ| D) |ψ⟩†

73. In time-dependent perturbation theory, the unperturbed Hamiltonian represents:
A) The full quantum mechanical system
B) The perturbed system without any external influences
C) The perturbed system including all external influences
D) The perturbed system with minimal external influences

74. In the WKB Approximation, the turning points of the wave function correspond to locations where the kinetic energy is equal to:
A) Zero B) The potential energy
C) The total energy D) The angular momentum

75. The Born Approximation becomes more accurate when the energy of the incident particle is:
A) High B) Low C) Constant D) Relativistic

76. Which thermodynamic potential is minimized at equilibrium for a closed system at constant temperature and volume?
A) Internal energy (U)
B) Enthalpy (H)
C) Helmholtz free energy (A)
D) Gibbs free energy (G)

77. ------ensemble allows for the exchange of both energy and particles with a reservoir.
A) Canonical B) Grand Canonical
C) Microcanonical D) Isothermal-Isobaric

78. In statistical mechanics, what is the relationship between the partition function and the Helmholtz free energy (F)?
A) $F = -kT \ln(Z)$ B) $F = -kT \ln(g)$
C) $F = E - TS$ D) $F = -\ N$

79. What happens to the size of a Bose-Einstein condensate as the temperature decreases below the critical temperature?
A) It shrinks B) It remains the same
C) It expands D) It disappears

80. In statistical mechanics, how many coordinates are typically used to specify a point in phase space for a system with N particles in three dimensions?
A) N B) 3N C) 5N D) 6N

81. Which of the following is **not** a Maxwell equation?
A) $(\partial T/\partial V) = -(\partial p/\partial S)$ B) $(\partial p/\partial T) = (\partial S/\partial V)$
C) $(\partial V/\partial T) = -(\partial S/\partial p)$ D) $(\partial T/\partial p) = -(\partial V/\partial S)$

82. When solving Laplace's equation in spherical coordinates for a spherically symmetric charge distribution, the general solution for the electric potential V(r) is:
A) $V(r) = k/r$ B) $V(r) = kr$ C) $V(r) = k/r^2$ D) $V(r) = kr^2$

83. In a Young's double-slit experiment the fringe width is 0.2 mm. If the wavelength of light used is increased by 10% and the separation between the slits is also increased by 10%, the fringe width will be:
A) 0.20 mm B) 0.401 mm
C) 0.242 mm D) None of these

84. What is the speed of light in glycerin (n = 1.5) expressed in terms of the speed of light in a vacuum?
A) 0.75c B) 1.5c C) 0.667c D) 0.333c

85. The property of electrons described by the term "spin" in quantum mechanics:
A) Physical rotation
B) Orbital motion
C) Intrinsic angular momentum
D) Vibrational energy

86. Which type of coupling, LS or JJ, is more commonly used to describe the electronic structure of atoms?
A) LS coupling B) JJ coupling
C) Both A and B D) Neither A nor B

87. The parameter used to describe the position of a signal in an NMR spectrum:
A) Spin number B) Magnetic field strength
C) Chemical shift D) Relaxation time

88. The selection rule for rotational transitions in diatomic molecules is $\Delta J = ?$
A) 0 B) ±1 C) ±2 D) ±3

89. The Zeeman Effect is often used to study and characterize which of the following properties of atoms or molecules?
A) Electrical charge B) Mass
C) Chemical reactivity D) Spin and magnetic moment

90. Parity is a property that describes the:
A) Charge of a particle
B) Mass of a particle
C) Spatial symmetry of a nuclear state
D) Spin of a particle

91. According to the liquid drop model, which type of nuclei tend to be more stable?
A) Those with a large number of protons
B) Those with an odd number of neutrons
C) Those with a high binding energy per nucleon
D) Those with a high surface area

92. The exchange of which particles mediates the strong nuclear force responsible for the nucleon-nucleon potential?
A) Electrons B) Photons C) Neutrinos D) Mesons

93. The Higgs boson is associated with which fundamental physical property?
A) Mass B) Electric charge
C) Spin D) Color charge

94. Which of the following is an example of a strange baryon, consisting of three quarks with at least one strange quark?
A) Pion B) Kaon
C) Lambda (Λ-baryon) D) Electron

95. The semi-empirical mass formula predicts that the binding energy per nucleon is highest for nuclei with:
A) Even numbers of protons and neutrons
B) Odd numbers of protons and even numbers of neutrons
C) Odd numbers of protons and odd numbers of neutrons
D) Even numbers of protons and odd numbers of neutrons

96. Which of the following lattices has the highest void fraction?
A) Hexagonal close packed B) Body centered cubic
C) Face centered cubic D) Primitive cubic

97. What is the Debye frequency?
A) The frequency at which phonons become inaudible
B) The highest frequency of phonons in a crystal
C) A measure of phonon scattering
D) The frequency of the fastest-moving phonons

98. Which type of phase transition in solids typically exhibits hysteresis?
A) First-order
B) Second-order
C) Both first-order and second-order
D) Neither first-order nor second-order

99. Which of the following is a characteristic feature of Type I superconductors?
A) Zero electrical resistance
B) Perfect diamagnetism below Tc
C) Ability to carry both electric and magnetic fields
D) High critical magnetic field (Hc)

100. The type of defect which is responsible for the coloration of some gemstones:
A) Vacancy defect B) Interstitial defect
C) Frenkel defect D) Schottky defect

101. The type of dislocation which results from the shearing of atomic planes within a crystal lattice:
A) Edge dislocation B) Screw dislocation
C) Mixed dislocation D) Vacancy dislocation

102. Which of the following materials is known to exhibit quasi-crystal structures?
A) Diamond B) Silicon C) Aluminium D) Graphite

103. In a transistor, I_C = 100 mA and I_E =100.5 mA. The value of β is:
A) 100 B) 50 C) about 1 D) 200

104. The phase difference between the input and output voltages in a common base arrangement is:
A) 180º B) 90º C) 270º D) 0º

105. If the power and current gains of a transistor amplifier are 16500 and 100 respectively, then voltage gain is:
A) 165 B) 165 × 104 C) 100 D) None of these

106. RC coupling is **not** used to amplify extremely low frequencies because:
A) There is considerable power loss
B) There is hum in the output
C) Electrical size of coupling capacitor becomes very large
D) None of these

107. The open-loop gain of an ideal op-amp is:
A) 0 dB B) 1 dB C) Infinite D) 20 dB

108. The decimal equivalent of the hexadecimal number "1A" is:
A) 10 B) 26 C) 16 D) 28

109. In a clocked SR flip-flop, the role of the clock signal:
A) It sets the Q output
B) It resets the Q output
C) It enables or disables the flip-flop
D) It toggles the flip-flop

110. The digital integrated circuit which is commonly used for binary addition:
A) Flip-flop B) Counter C) Multiplexer D) Full adder

111. How many general-purpose registers are there in the 8085 microprocessor?
A) 2 B) 4 C) 6 D) 8

112. Calculate the energy of a photon with a wavelength of 600 nm.
A) 3.31×10^{-19} J B) 2.48×10^{-19} J
C) 1.24×10^{-6} J D) 6.63×10^{-34} J

113. The moment of inertia of a uniform circular disc of radius R and mass M about an axis touching the disc at its diameter and normal to the disc is :
A) $I = (3/2)MR^2$ B) $I = (1/2)MR^2$
C) $I = (1/3)MR^2$ D) $I = MR^2$

114. Two point charges, +5 C and -2 C, are placed 3 meters apart. What is the electric potential energy of the system?
A) 3mJ B) 0.3mJ C) -3mJ D) -0.3mJ

115. Calculate $\int_0^{2\pi} \sin(2x)\, dx$:

A) 0 B) π C) -π D) 2π

116. A steel beam with a Young's Modulus of 210 GPa experiences a strain of 0.002. What is the stress applied to the beam?

A) 0.42 MPa B) 420 MPa
C) 2.1 MPa D) 0.000021GPa

117. If a 6 V battery is connected to three resistors in parallel with values of 2 ohms, 3 ohms, and 6 ohms, the total current in the circuit is:

A) 1 A B) 6 A C) 3 A D) 4 A

118. Find the limit as x approaches 3 for the function $f(x) = (x^2 - 9)/(x^2 - 3x)$:

A) 0 B) 1 C) 2 D) Undefined

119. A capacitor has a capacitance of 20 F and is charged to a voltage of 100 V. What is the energy stored in the capacitor?

A) 10 J B) 20 J C) 50 J D) 100 J

120. Which of the following is a valid quantum number for an electron in an atom?

A) $n = 3, l = 2, m_l = 3, m_s = +1/2$
B) $n = 4, l = 2, m_l = 2, m_s = -1/2$
C) $n = 1, l = 1, m_l = -1, m_s = 0$
D) $n = 2, l = 3, m_l = 0, m_s = -1/2$
