



General Instructions

- (i) The test is of 2 hours duration.
- (ii) This test paper consists of 120 questions. The maximum marks are 120.
- (iii) Each question carries +1 marks for correct answer and there is no negative marking for wrong answer.

1. The Hall–Petch relation correlates yield stress with

- (A) Temperature
 - (B) Strain rate
 - (C) Grain size
 - (D) Dislocation density
-

2. Cast iron typically shows

- (A) High ductility
 - (B) Yield point
 - (C) Brittle fracture
 - (D) Large plastic deformation
-

3. The Clausius–Mossotti equation relates

- (A) Polarization and temperature
 - (B) Dielectric constant and polarizability
 - (C) Conductivity and permittivity
 - (D) Stress and strain
-

4. Stacking faults are commonly observed in

- (A) BCC metals
 - (B) FCC metals
 - (C) Ionic crystals
 - (D) Polymers
-

5. Burgers vector represents

- (A) Slip plane
 - (B) Magnitude and direction of lattice distortion
 - (C) Dislocation density
 - (D) Atomic spacing
-

6. The smallest repeating unit of a crystal lattice is called

- (A) Unit cell
 - (B) Primitive cell
 - (C) Wigner–Seitz cell
 - (D) Crystal system
-

7. Type-II superconductors are characterized by

- (A) Single critical field
 - (B) No mixed state
 - (C) Two critical magnetic fields
 - (D) Complete flux expulsion
-

8. A semiconductor laser operates mainly on the principle of

- (A) Spontaneous emission
 - (B) Stimulated emission
 - (C) Black body radiation
 - (D) Photoelectric effect
-

9. Which of the following is a Bravais lattice?

- (A) Cubic
 - (B) Tetragonal
 - (C) Face-centered cubic
 - (D) Hexagonal
-

10. The crystal structure of aluminum at room temperature is

- (A) BCC
 - (B) FCC
 - (C) HCP
 - (D) Diamond cubic
-

11. A vacancy is classified as a

- (A) Point defect
 - (B) Surface defect
 - (C) Line defect
 - (D) Volume defect
-

12. The number of crystal systems in three dimensions is

- (A) 5
 - (B) 7
 - (C) 10
 - (D) 14
-

13. Dislocation climb occurs due to

- (A) Shear stress
 - (B) Vacancy diffusion
 - (C) Applied magnetic field
 - (D) Grain boundary motion
-

14. The number of atoms per unit cell in FCC structure is

- (A) 8
- (B) 6

- (C) 4
 - (D) 2
-

15. Cross-slip is possible only for

- (A) Edge dislocations
 - (B) Grain boundaries
 - (C) Mixed dislocations
 - (D) Screw dislocations
-

16. Hot working differs from cold working because it

- (A) Increases strain hardening
 - (B) Promotes recrystallization
 - (C) Reduces ductility
 - (D) Increases dislocation density
-

17. Proof stress is used when

- (A) Clear yield point exists
 - (B) Material fractures elastically
 - (C) Yield point is not well defined
 - (D) Material is brittle
-

18. Aluminum alloy stress–strain curve shows

- (A) Sharp yield point
 - (B) Large elastic region only
 - (C) Brittle fracture
 - (D) Smooth yielding
-

19. Quantum well lasers achieve lower threshold current because of

- (A) Larger active volume
 - (B) Carrier confinement
 - (C) Higher losses
 - (D) Lower gain
-

20. The active medium in a semiconductor laser is

- (A) Insulator
 - (B) Metal
 - (C) p–n junction
 - (D) Dielectric
-

21. Composites are designed primarily to

- (A) Combine desirable properties
 - (B) Reduce cost
 - (C) Improve conductivity only
 - (D) Replace metals
-

22. Grain refinement improves strength mainly by

- (A) Increasing slip length
 - (B) Increasing dislocation mobility
 - (C) Hindering dislocation motion
 - (D) Reducing elastic modulus
-

23. Which mechanism involves the movement of atoms to form a mirror image of the crystal structure across a plane?

- (A) Slip
 - (B) Climbing
 - (C) Creep
 - (D) Twinning
-

24. Which material typically exhibits a distinct upper and lower yield point in its stress-strain curve?

- (A) Pure Aluminum
 - (B) Mild Steel
 - (C) Copper
 - (D) Gray Cast Iron
-

25. During the recovery stage of annealing, which property changes the most significantly?

- (A) Grain size
 - (B) Mechanical hardness
 - (C) Electrical conductivity
 - (D) Macroscopic shape
-

26. In which structure the Copper and Aluminum crystallize?

- (A) BCC
 - (B) FCC
 - (C) HCP
 - (D) Simple Cubic
-

27. The area under the engineering stress-strain curve up to the point of fracture represents

- (A) Resilience
 - (B) Elastic Modulus
 - (C) Hardness
 - (D) Toughness
-

28. Which of the following is not a mechanism of polymerization?

- (A) Addition
 - (B) Condensation
 - (C) Sintering
 - (D) Ring-opening
-

29. In a fiber-reinforced composite, the primary role of the matrix is to

- (A) Carry the major load
 - (B) Transfer stress to the fibers and protect them
 - (C) Increase the density
 - (D) Decrease the thermal conductivity
-

30. Electrical conductivity in metals primarily depends on

- (A) Number of free electrons
 - (B) Atomic mass
 - (C) Grain size
 - (D) Lattice defects
-

31. Free electron theory treats conduction of electrons in metals as:

- (A) Classical gas of electrons
 - (B) Bound electrons
 - (C) Ion cores
 - (D) Magnetic dipoles
-

32. The point on the stress-strain curve beyond which the material will not return to its original shape when the load is removed is called the:

- (A) Proportional Limit
 - (B) Fracture Point
 - (C) Ultimate Tensile Strength
 - (D) Elastic Limit
-

33. The band gap of an intrinsic semiconductor increases with:

- (A) Temperature
 - (B) Pressure
 - (C) Doping
 - (D) Time
-

34. Diamagnetic materials have:

- (A) Permanent magnetic moments
 - (B) Magnetic susceptibility < 0
 - (C) Magnetic susceptibility > 0
 - (D) Hysteresis
-

35. The refractive index of a material is defined as:

- (A) Ratio of velocity of light in vacuum to velocity in material
 - (B) Ratio of permittivity to permeability
 - (C) Absorption coefficient of light
 - (D) Polarization per unit field
-

36. A metal has one free electron per atom, density $\rho = 0.97 \text{ g/cm}^3$ and molar mass $M = 39 \text{ g/mol}$. Calculate the Fermi energy E_F of the metal:

- (A) 4.5 eV
 - (B) 7.0 eV
 - (C) 5.5 eV
 - (D) 1.78 eV
-

37. A metal has free electron density $n = 8.5 \times 10^{28} \text{ m}^{-3}$ and relaxation time $\tau = 2.5 \times 10^{-14} \text{ s}$. Calculate its electrical conductivity (σ):

- (A) $3.4 \times 10^7 \text{ S/m}$
 - (B) $2.0 \times 10^7 \text{ S/m}$
 - (C) $1.0 \times 10^7 \text{ S/m}$
 - (D) $5.0 \times 10^7 \text{ S/m}$
-

38. Which of the following best describes the general properties of Ceramics?

- (A) Soft and flexible
 - (B) Brittle and insulating
 - (C) Metallic and conductive
 - (D) Ductile and malleable
-

39. Composite materials are typically made up of:

- (A) Single-phase materials
 - (B) Matrix and reinforcement
-

- (C) Only polymers
 - (D) Only metals
-

40. In composite materials, Matrices mainly function to:

- (A) Transfer load to reinforcement
 - (B) Increase brittleness
 - (C) Reduce density
 - (D) Absorb light
-

41. Nanomaterials can be synthesized by the following approaches

- (1) Top-down approaches only
 - (2) Bottom-up approaches only
 - (3) Both Top-down and Bottom-up approaches
 - (4) Only mechanical grinding
-

42. Dielectric constant of a material measures

- (1) Electrical conductivity
 - (2) Polarizability in electric field
 - (3) Magnetic susceptibility
 - (4) Optical absorption
-

43. Soft magnetic materials are mainly used in

- (1) Permanent magnets
 - (2) Transformers and cores
 - (3) Optical devices
 - (4) None of the above
-

44. Ferrimagnetic materials are found in

- (1) Iron oxides like magnetite
- (2) Copper

- (3) Silicon
 - (4) Aluminium
-

45. Top-down approach in nanotechnology involves

- (1) Building from atoms
 - (2) Electron-hole recombination
 - (3) Chemical self-assembly
 - (4) Breaking bulk material into nano-size
-

46. In band theory, metals have

- (1) Completely filled valence band and empty conduction band
 - (2) Partially filled conduction band
 - (3) Large band gap
 - (4) No electrons
-

47. The critical temperature of a superconductor is the temperature at which

- (1) Resistance drops to zero
 - (2) Magnetic susceptibility becomes zero
 - (3) Dielectric constant diverges
 - (4) Electron mobility decreases
-

48. The phenomenon where light is emitted from a material after the absorption of photons (excitation) is generally called

- (1) Luminescence
 - (2) Refraction
 - (3) Polarization
 - (4) Dispersion
-

49. In a composite material, the phase that is continuous and surrounds the other phase is called the

- (1) Reinforcement
 - (2) Matrix
-

- (3) Fiber
 - (4) Dispersoid
-

50. The method commonly used for fabricating continuous fiber-reinforced polymer composites, specifically for making pipes or tanks is

- (1) Injection Molding
 - (2) Filament Winding
 - (3) Sintering
 - (4) Blow Molding
-

51. As the size of a material reduces to the nanoscale, the surface area-to-volume ratio

- (1) Increases significantly
 - (2) Decreases
 - (3) Remains constant
 - (4) Becomes zero
-

52. Above Curie temperature, a ferromagnetic material becomes

- (1) Diamagnetic
 - (2) Superconducting
 - (3) Paramagnetic
 - (4) Antiferromagnetic
-

53. Which combination of mechanical properties is typically shown by Ceramics?

- (1) High ductility and low toughness
 - (2) High hardness and high brittleness
 - (3) Low hardness and high ductility
 - (4) High tensile strength and high toughness
-

54. Concrete is a classic example of which type of composite?

- (1) Laminar composite
- (2) Particulate composite

- (3) Fiber-reinforced composite
 - (4) Sandwich panel
-

55. Quantum confinement effects become significant when the size of the particle is comparable to the

- (1) Wavelength of visible light
 - (2) Exciton Bohr radius
 - (3) Mean free path of a gas molecule
 - (4) Grain size of a metal
-

56. An inverting amplifier has a phase shift of

- (A) 0°
 - (B) 90°
 - (C) 180°
 - (D) 270°
-

57. An op-amp adder sums voltages using

- (A) Voltage divider
 - (B) Series connection of resistors
 - (C) Inverting configuration
 - (D) Differential pair
-

58. Integrator using op-amp uses

- (A) Resistor in feedback
 - (B) Capacitor in feedback
 - (C) Inductor in input
 - (D) No feedback
-

59. Whenever a JFET operates above pinch-off voltage

- (A) Drain current starts decreasing
 - (B) Drain current remains nearly constant
-

- (C) Depletion regions become smaller
 - (D) Drain current increases steeply
-

60. A half-adder has

- (A) One input only
 - (B) Two outputs only
 - (C) Two inputs and two outputs
 - (D) Three outputs
-

61. Basic function of ADC is to convert

- (A) Analog to Digital
 - (B) Digital to Analog
 - (C) Voltage to Current
 - (D) Current to Voltage
-

62. BJT in common-emitter configuration has

- (A) High input, high output
 - (B) Low input, high output
 - (C) High input, low output
 - (D) Low input, low output
-

63. DFT converts

- (A) Time domain to Frequency domain
 - (B) Frequency domain to Time domain
 - (C) Voltage to Current
 - (D) Analog to Digital
-

64. CMOS technology is preferred for

- (A) Oscillators
 - (B) Resistors
 - (C) High power circuits
 - (D) Low power circuits
-

65. The characteristic of an ideal operational amplifier is

- (A) Infinite input impedance and zero output impedance
 - (B) Zero input impedance and infinite output impedance
 - (C) Infinite input impedance and infinite output impedance
 - (D) Zero input impedance and zero output impedance
-

66. Which of the following logic gate is known as a "Universal Gate"?

- (A) XOR
 - (B) AND
 - (C) NAND
 - (D) OR
-

67. A CMOS inverter consists of

- (A) A PMOS pull-up and an NMOS pull-down network
 - (B) An NMOS pull-up and a PMOS pull-down network
 - (C) Two NMOS transistors
 - (D) Two PMOS transistors
-

68. How many flip-flops are required to design a Mod-10 counter?

- (A) 3
 - (B) 4
 - (C) 10
 - (D) 5
-

69. The process of converting a continuous-time signal into a discrete-time signal is called

- (A) Quantization
 - (B) Sampling
 - (C) Encoding
 - (D) Aliasing
-

70. Charge Coupled Devices (CCDs) are primarily used in

- (A) High-power amplification
 - (B) Digital Logic
 - (C) Image sensing and signal processing
 - (D) Voltage regulation
-

71. A 4-bit ripple counter uses flip-flops with a propagation delay of 50 ns each. The maximum clock frequency that can be used is:

- (A) 5 MHz
 - (B) 10 MHz
 - (C) 20 MHz
 - (D) 50 MHz
-

72. A 10-bit ADC has a reference voltage of 10.24 V. The resolution (step size) of the converter is:

- (A) 1 mV
 - (B) 10 mV
 - (C) 10.24 mV
 - (D) 100 mV
-

73. "Latch-up" in CMOS circuits is caused by the formation of parasitic:

- (A) Capacitors
 - (B) Inductors
 - (C) Thyristors (SCRs)
 - (D) Resistors
-

74. A practical op-amp differentiator requires a small resistor in series with the input capacitor to:

- (A) Increase gain
- (B) Reduce input impedance
- (C) Improve stability and reduce high-frequency noise sensitivity
- (D) Increase bandwidth

75. In a MOSFET, if the source-to-body voltage $V_{SB} > 0$ (for NMOS), the threshold voltage V_T :

- (A) Decreases
 - (B) Increases
 - (C) Remains constant
 - (D) Becomes negative
-

76. D/A converter resolution improves with:

- (A) More bits
 - (B) Lower voltage
 - (C) Faster clock
 - (D) Larger load
-

77. Digital signals for FFT are assumed:

- (A) Periodic
 - (B) Non-periodic
 - (C) Random
 - (D) DC only
-

78. CMOS inverter output is LOW when input is:

- (A) LOW
 - (B) HIGH
 - (C) Floating
 - (D) Zero current
-

79. A counter with modulus 8 has:

- (A) 3 flip-flops
 - (B) 4 flip-flops
 - (C) 2 flip-flops
 - (D) 8 flip-flops
-

80. MOSFET cutoff occurs when:

- (A) $V_{GS} < V_{th}$
 - (B) $V_{GS} > V_{th}$
 - (C) $V_{DS} = 0$
 - (D) $V_{GS} = V_{DS}$
-

81. The de Broglie wavelength of a particle is:

- (A) $\frac{h}{p}$
 - (B) $\frac{p}{h}$
 - (C) $\frac{h^2}{p}$
 - (D) $\sqrt{\frac{h}{p}}$
-

82. The Schrödinger equation is:

- (A) $H\psi = E\psi$
 - (B) $F = ma$
 - (C) $E = mc^2$
 - (D) $pV = nRT$
-

83. The time-independent Schrödinger equation is fundamentally an eigenvalue equation for which operator?

- (A) Momentum Operator
 - (B) Hamiltonian Operator
 - (C) Position Operator
 - (D) Parity Operator
-

84. The ground state energy of the Hydrogen atom is approximately:

- (A) -1.5 eV
 - (B) -3.4 eV
 - (C) -13.6 eV
 - (D) -54.4 eV
-

85. The wavefunction of a system of identical fermions must be:

- (A) Symmetric under particle exchange
 - (B) Antisymmetric under particle exchange
 - (C) Symmetric for spin, antisymmetric for space
 - (D) Unrelated to exchange symmetry
-

86. The energy levels of a quantum harmonic oscillator are:

- (1) Degenerate
 - (2) Equally spaced
 - (3) Proportional to n^2
 - (4) Continuous
-

87. Particles with integer spin are called:

- (1) Fermions
 - (2) Bosons
 - (3) Leptons
 - (4) Baryons
-

88. The second-order correction to the energy of the ground state is always:

- (1) Zero
 - (2) Imaginary
 - (3) Positive
 - (4) Negative
-

89. Harmonic oscillator potential is:

- (1) $V = \frac{m\omega^2 x^2}{2}$
 - (2) $V = mgh$
 - (3) $V = kx$
 - (4) $V = 0$
-

90. The Born's approximation is applicable for:

- (1) High energy, low atomic number for scatterer
 - (2) Low energy, low atomic number for scatterer
 - (3) High energy, high atomic number for scatterer
 - (4) Low energy, high atomic number for scatterer
-

91. The following are the centroidal coordinates of semicircular plane of 16π cm diameter and is symmetric about x -axis.

- (1) $(0, \frac{32}{3})$
 - (2) $(\frac{32}{3}, 0)$
 - (3) $(0, \frac{16}{3})$
 - (4) $(\frac{16}{3}, 0)$
-

92. The polar moment of inertia of a circular plane of diameter about its centroid is (in cm^4):

- (1) 128π
 - (2) 156π
 - (3) 64π
 - (4) 312π
-

93. A ball of mass 0.1 kg, initially at rest, is dropped from height of 1 m. Ball hits the ground and bounces off the ground. Upon impact with the ground, the velocity reduces by 20%. The height (in m) to which the ball will rise is:

- (1) 0.64
 - (2) 0.86
 - (3) 0.34
 - (4) 0.72
-

94. Which of the following has the highest specific heat capacity?

- (1) Copper
 - (2) Iron
 - (3) Aluminium
 - (4) Water *(Note: Explicit target option implied by standard thermodynamic comparisons)*
-

95. A uniform cylinder of radius 10 cm and mass 20 kg is mounted so as to rotate freely about a horizontal axis that is parallel to and 5.0 cm from the central longitudinal axis of the cylinder. What is the rotational inertia of the cylinder about the axis of rotation?

- (1) $0.15 \text{ kg} \cdot \text{m}^2$
 - (2) $0.21 \text{ kg} \cdot \text{m}^2$
 - (3) $0.26 \text{ kg} \cdot \text{m}^2$
 - (4) $0.17 \text{ kg} \cdot \text{m}^2$
-

96. When a torque of 32.0 Nm is applied to a certain wheel, the wheel acquires an angular acceleration of 25.0 units. What is the rotational inertia of the wheel?

- (1) $1.25 \text{ kg} \cdot \text{m}^2$
 - (2) $1.28 \text{ kg} \cdot \text{m}^2$
 - (3) $2.28 \text{ kg} \cdot \text{m}^2$
 - (4) $2.25 \text{ kg} \cdot \text{m}^2$
-

97. The minimum value of angular momentum by coupling three angular momenta 1, $\frac{3}{2}$ and $\frac{5}{2}$ is:

- (1) -5
 - (2) $\frac{1}{2}$
 - (3) 0
 - (4) 1
-

98. If a particle has mass of 20 kg moves with an acceleration of 2.5 m/s^2 , then the magnitude of force acting on the particle is (in $\text{kg} \cdot \text{m/s}^2$):

- (1) 25
 - (2) 50
 - (3) 75
 - (4) 100
-

99. The centre of gravity for a solid hemisphere about its diametral base having diameter 120 cm and is symmetric about y-axis is (in cm):

- (1) 22.5
 - (2) 90
 - (3) 135
 - (4) 45
-

100. In a simple harmonic motion (SHM), the acceleration is proportional to:

- (1) Velocity
 - (2) Displacement and opposite in direction
 - (3) Time
 - (4) Square of velocity
-

101. The driving force for heat conduction is called as:

- (1) Temperature gradient
 - (2) Concentration gradient
 - (3) Pressure gradient
 - (4) Velocity gradient
-

102. Furnace efficiency is best defined as the ratio of

- (1) Heat input to heat output
 - (2) Heat stored in stock to total heat input
 - (3) Heat utilized by the stock to the heat released by the fuel
 - (4) Heat losses to heat input
-

103. A Sankey diagram is primarily used to represent

- (1) Temperature distribution in a furnace
 - (2) Pressure drops in a piping system
 - (3) Energy balance and heat flow distribution
 - (4) Electrical wiring diagrams
-

104. Saturated steam at 100 °C condenses on the outside of a tube. Cold fluid enters the tube at 20 °C and exits at 50 °C. The value of the Log Mean Temperature Difference (in °C) is:

- (1) 54.89
 - (2) 63.83
 - (3) 72.39
 - (4) 89.36
-

105. Consider a counter-flow heat exchanger with the inlet temperatures of two fluids (1 and 2) being $T_1 = 300$ K and $T_2 = 350$ K. The heat capacity rates of the two fluids are $C_1 = 1000$ W/K and $C_2 = 400$ W/K, and the effectiveness of the heat exchanger is 0.5. The actual heat transfer rate is (in kW)

- (1) 12
 - (2) 15
 - (3) 18
 - (4) 10
-

106. Adding insulation to a cylindrical pipe with a radius smaller than the critical radius of insulation will

- (1) Decrease heat loss
 - (2) Increase heat loss
 - (3) Have no effect
 - (4) Stop heat flow completely
-

107. The primary mode of heat transfer to the workpiece in a salt bath furnace is

- (1) Radiation
 - (2) Convection (Liquid to Solid)
 - (3) Conduction (Gas to Solid)
 - (4) Induction
-

108. High excess air in a furnace combustion process generally

- (1) Increases furnace efficiency
 - (2) Decreases furnace efficiency due to stack losses
 - (3) Increases flame temperature
 - (4) Reduces fuel consumption
-

109. Fourier's law of heat conduction relates

- (1) Heat flux to temperature gradient
 - (2) Heat flux to pressure gradient
 - (3) Heat flux to velocity gradient
 - (4) Heat flux to density
-

110. Steady-state conduction implies

- (1) Temperature does not change with time
 - (2) Temperature varies with time
 - (3) Heat flux is zero
 - (4) Convection occurs
-

111. Entropy of a perfect crystal at 0 K is

- (1) Negative
 - (2) Infinity
 - (3) Constant
 - (4) Zero
-

112. Boltzmann equation relates

- (1) Entropy to the number of microstates $S = k \ln \Omega$
 - (2) Enthalpy to pressure
 - (3) Work to volume
 - (4) Energy to temperature
-

113. Gibbs-Helmholtz equation relates

- (1) Gibbs free energy, enthalpy and temperature
 - (2) Entropy and work
 - (3) Internal energy and volume
 - (4) Heat and temperature
-

114. Chemical potential is

- (1) Work done by system
 - (2) Total enthalpy
 - (3) Partial molar Gibbs free energy
 - (4) Heat absorbed
-

115. Mixing entropy arises due to

- (1) Volume change
 - (2) Heat transfer
 - (3) Work done
 - (4) Random distribution of components
-

116. Fundamental equation of state for ideal gas

- (1) $PV = nRT$
 - (2) $PV^2 = nRT$
 - (3) $\frac{P}{V} = nRT$
 - (4) $P + V = nRT$
-

117. A heat engine receives 1000 J of heat from a reservoir at 1000 K and rejects 600 J of heat to a sink at 300 K. This engine is

- (1) Reversible
 - (2) Irreversible
 - (3) Impossible
 - (4) Perfectly efficient
-

118. For a van der Waals gas, the internal energy U

- (1) Depends only on Temperature
 - (2) Depends on both Temperature and Volume
 - (3) Is zero
 - (4) Depends only on Volume
-

119. For a unary (one component) system, the maximum number of phases that can coexist in equilibrium at the triple point is

- (1) 1
 - (2) 2
 - (3) 3
 - (4) 0
-

120. Mixing two distinct ideal gases results in an increase in entropy primarily because of

- (1) Increase in internal energy
 - (2) Increase in molecular interactions
 - (3) Increase in spatial uncertainty
 - (4) Chemical reaction between gases
-