

ENTRANCE EXAMINATIONS, 2015

QUESTION PAPER


M.Tech.(Materials Engineering)

Marks: 75

Time: 2.00 hrs

Hall Ticket no:

- I. Write your Hall Ticket Number on the OMR Answer Sheet given to you. Also write the Hall Ticket Number in the Space provided above.
 - II. Read the following instructions carefully before answering the questions.
 - III. This Question paper has TWO parts: **PART 'A' and PART 'B'**
1. **Part 'A':** It consists of 25 objective type questions of one mark each.
There is a negative marking of 0.33 marks for every wrong answer.
The marks obtained by a candidate in this part will be used for resolving tie cases.
 2. **Part 'B':** It consists of 50 objective questions of one mark each.
There is no negative marking in this part.
 3. **All questions are to be answered.** Answers for these questions are to be entered on the OMR sheet, filling the appropriate circle against each question. For example, if the answer to a question is (d), it should be marked as below:



(A) (B) (C) ●
 4. Hand over the OMR answer sheet at the end of the examination to the invigilator.
 5. Calculators are permitted. Log tables are not allowed. **Mobile phones are NOT permitted inside the Examination Hall.**
 6. This book contains 18 pages including this cover sheet.

Part A

1. When an ionic solid is dissolved in water, the ions are free and wander in the solution. This is because of
 - A. High dielectric constant of water
 - B. Low dielectric constant of water
 - C. Low density of water
 - D. None of these

2. The potential energy at the equilibrium spacing of a diatomic molecule is
 - A. zero
 - B. minimum
 - C. maximum
 - D. unity

3. A plane intercepts at a , $b/2$, $3c$ in a simple cubic unit cell. The Miller indices of the plane are
 - A. (2 6 1)
 - B. (1 3 2)
 - C. (1 2 3)
 - D. (3 6 1)

4. The wavelength associated with a moving particle
 - A. Depends upon the charge of the particle
 - B. Depends upon the momentum of the particle
 - C. Depends upon the medium in which the particles travels
 - D. Depends on the mass of the particle.

5. When temperature increases, the lattice scattering increases and hence mobility
 - A. decreases
 - B. increases
 - C. remains unaltered
 - D. none of these

6. Which of the following increases when copper is hard drawn into wires
- A. Diameter
 - B. Cross sectional area
 - C. Specific gravity
 - D. Resistivity
7. In a ferromagnetic material, susceptibility is
- A. very small and positive
 - B. very small and negative
 - C. very large and positive
 - D. very large and negative
8. All materials have
- A. Paramagnetic property
 - B. Ferromagnetic property
 - C. Diamagnetic property
 - D. Ferrimagnetic property
9. In a p-type semiconductor, the concentration of holes is proportional to the square root of
- A. The concentration of donor impurities
 - B. The concentration of acceptor impurities
 - C. The concentration of intrinsic impurities
 - D. None of these
10. When a monoatomic gas atom is placed in a uniform electric field E , the displacement of the nucleus is proportional to
- A. E
 - B. E^2
 - C. $1/E$
 - D. independent of E

11. At optical frequencies, the dielectric constant is

- A. linearly proportional to the refractive index
- B. linearly proportional to the square of the refractive index
- C. inversely proportional to the refractive index
- D. inversely proportional to the square of the refractive index

12. In a ferroelectric material, as the applied field is gradually reduced to zero, the polarization still left is known as

- A. Coercive polarization
- B. Remanent polarization
- C. Zero polarization
- D. Positive polarization

13. \vec{a} and \vec{b} are two arbitrary vectors. $\vec{a} \cdot \vec{b}$ and $\vec{a} \times \vec{b}$ denote respectively the scalar and vector products of \vec{a} and \vec{b} . Then

- A. $\vec{a} \times (\vec{b} \times (\vec{b} \times \vec{a})) = (\vec{a} \cdot \vec{b}) (\vec{a} \times \vec{b})$
- B. $\vec{a} \times (\vec{b} \times (\vec{b} \times \vec{a})) = -(\vec{a} \cdot \vec{b}) (\vec{a} \times \vec{b})$
- C. $\vec{a} \times (\vec{b} \times (\vec{b} \times \vec{a})) = (\vec{a} \cdot \vec{b}) (|\vec{a}| \vec{b} - |\vec{b}| \vec{a})$
- D. $\vec{a} \times (\vec{b} \times (\vec{b} \times \vec{a})) = 0$

14. A material that exhibits non-Hookian elasticity is

- A. Steel
- B. German silver
- C. Rubber
- D. Alloy Super

15. Let $x = \frac{1+10+10^2+\dots+10^{19}}{1+10+10^2+\dots+10^9} - 1$, Then the value of x is

- A. 10^{10}
- B. $\frac{1}{9}10^{10}$
- C. 10^9
- D. 10^9+1

16. von Mises yield criterion is dependent on the ____ invariant of the deviatoric tensor.

- A. First
- B. Second
- C. Third
- D. Fourth

17. The number of independent elastic constants required to describe the elastic energy of a material with triclinic structure is

- A. 21
- B. 14
- C. 7
- D. 28

18. Temperature compensated strain rate is popularly known as

- A. Zeta potential
- B. Zener - Hollomon Parameter
- C. empirical constant
- D. kinetic constant

19. The value of the sum, $S = \sum_{j=1}^{10} \cos(2\pi j/11)$, is

- A. -1
- B. 1
- C. 1/10
- D. -1/10

20. Vacancy climb is an example of overcoming a

- A. Short range obstacle
- B. Long range obstacle
- C. Barrier-free process
- D. Cryogenic obstacle

21. $\lim_{x \rightarrow \pi/2} \left(\frac{\cos^2(x)}{x^2 - \pi x + \pi^2/4} \right)$ is

- A. 1
- B. 2
- C. 0
- D. indeterminate

22. The original form of Griffith's theory of fracture does not apply to

- A. Brittle materials
- B. Solids in general
- C. Metals
- D. Brittle ceramics

23. $\frac{d}{dx} \sin(2^x)$ is

- A. $\ln(2)2^x \cos(2^x) \frac{1}{x}$
- B. $2^x \cos(2^x) \frac{1}{x}$
- C. $2^{x-1} \cos(2^x)$
- D. $2^{x-1} \cos(2^x) \frac{1}{x}$

24. Dynamic recovery is present in materials

- A. with high stacking fault energy
- B. with low stacking fault energy
- C. with orthorhombic structure only
- D. of all types

25. Deformation twins are commonly seen in

- A. FCC materials
- B. BCC materials
- C. HCP materials
- D. nanostructured materials

Part B

26. The conditions to be satisfied by the constants α , β and γ for the function $f(x) = x^3/3 + \alpha x^2/2 + \beta x + \gamma$ to have one maximum and one minimum is

- A. $\alpha^2 - 4\beta > 0$
- B. $\alpha^2 - 4\beta < 0$
- C. $\gamma > 0$ and $\alpha > 0$
- D. $\gamma < 0$ and $\alpha > 0$

27. Dead metal Zone is due to:

- A. Friction
- B. Temperature rise
- C. Low ductility of material
- D. High strength of material

28. The eigen pairs (eigen values and corresponding eigen vectors) of the matrix $\frac{1}{2} \begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$ are

- A. 0 & $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$ and 1 & $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$
- B. 0 & $\begin{pmatrix} 0 \\ 0 \end{pmatrix}$ and 1 & $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$
- C. 0 & $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$ and 1 & $\begin{pmatrix} -1 \\ 1 \end{pmatrix}$
- D. 1/2 & $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and 1/2 & $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$

29. LPG cylinders are made by

- A. Cold deep drawing
- B. Impact extrusion
- C. Hot deep drawing
- D. Flow forming

30. The function $x(t) = A \exp(-3t) \cos(4t - \phi)$, with A and ϕ constants, is a solution of the differential equation

$$\frac{d^2}{dt^2}x(t) + 2\beta \frac{d}{dt}x(t) + \omega^2x(t) = 0$$

If

- A. $\beta=3$ and $\omega=5$
- B. $\beta=-3$ and $\omega=5$
- C. $\beta=3$ and $\omega=4$
- D. $\beta=-3$ and $\omega=4$

31. A room temperature lubricant is

- A. Glass powder
- B. MoS_2
- C. Teflon sheet
- D. Copper

32. If $x = -4$ is one of the roots of the equation $x^3 - 11x + 20 = 0$, the other two roots are

- A. $2+i$ and $2-i$
- B. $-2+i$ and $-2-i$
- C. 3 and 1
- D. -1 and 5

33. Extrusion of rocks is possible in

- A. hydrostatic extrusion
- B. high temperature forging
- C. ausforming
- D. Smithy work

34. The value of the integral

$$I = \int_0^{5\pi/2} \frac{x \cos(x)}{x \cos(x) + \left(\frac{5\pi}{2} - x\right) \sin(x)} dx \quad \text{is}$$

- A. $5\pi/4$
- B. $5\pi/2$
- C. π
- D. 2π

35. Using powder metallurgy, one can

- A. overcome the limitations of the phase diagram
- B. make cheap products
- C. replace all forgings
- D. eliminate all cast products.

36. An example of AX_2 type of molecule with sp^3 hybridization of orbitals of the central atom is

- A. $PbCl_2$
- B. $BeCl_2$
- C. H_2O
- D. $ZnCl_2$

37. The possible solutions for x satisfying the following equation are

$$\det \begin{pmatrix} 2x-3 & x-1 & 2x-5 \\ x-4 & 2 & x-2 \\ 1-x & 3-x & 3-x \end{pmatrix} = 0$$

- A. 3 and 4
- B. 0, 3 and 4
- C. 1, 2 and 3
- D. -1 and 2

38. With the notation C_x representing concentration of x , the expression of pH in pH scale is given by,

- A. $-\log C_{H_3O^+}$
- B. $-\log C_{H_3O^-}$
- C. $\log C_{H_3O^+}$
- D. $-\log C_{H_2O}$

39. The family of an octahedral planes in a cubic crystal is

- A. {111}
- B. {110}
- C. {100}
- D. {112}

40. A commodity thermoplastic is

- A. Polyethylene
- B. Polyfuran
- C. Liquid crystal polymer
- D. Nylon

41. Polydispersity Index (PI) of a polymer with M_n as the number average molecular weight and M_w as the weight average molecular weight is

- A. M_w/M_n
- B. M_n/M_w
- C. $M_n \times M_w$
- D. $M_n + M_w$

42. The curve $3x^2 + 3y^2 + 2xy = 16$ is

- A. An ellipse with semimajor and minor axes $\sqrt{8}$ and 2 with semimajor axis making $3\pi/4$ radian with x-axis.
- B. A hyperbola with semi major and minor axes $\sqrt{8}$ and 2 with semi major axis making $\pi/4$ radian with x-axis.
- C. A circle of radius $4/\sqrt{3}$
- D. A pair of straight lines perpendicular to each other.

43. Which of the following functional groups would make a compound least polar?

- A. Phosphate
- B. Methyl
- C. Carboxyl
- D. Amino

44. The most ductile material among the following is

- A. Pb
- B. Sn
- C. Ag
- D. Al

45. Solution of the differential equation $\frac{d}{dt}x = -2xt$ with the initial condition $x(0)=2$ is

- A. $x(t) = 2\exp(-t^2)$
- B. $x(t) = 2\exp(-2t)$
- C. $x(t) = (2+t)\exp(-t)$
- D. $x(t) = \frac{1}{2}(2+t)^2$

46. For a simple cubic lattice $d_{100} : d_{110} : d_{111}$ is

- A. $\sqrt{3} : \sqrt{2} : \sqrt{6}$
- B. $\sqrt{3} : \sqrt{6} : \sqrt{2}$
- C. $\sqrt{6} : \sqrt{3} : \sqrt{2}$
- D. $\sqrt{2} : \sqrt{3} : \sqrt{6}$

47. The density of charge carriers in a pure semiconductor is proportional to temperature as

- A. T^2
- B. T^3
- C. $T^{1/2}$
- D. $T^{3/2}$

48. The angle between the two tangents to the parabola, $y^2=4x$ at $x=1/3$ is

- A. $2\pi/3$ radians
- B. $\pi/2$ radians
- C. $\pi/4$ radians
- D. $\pi/6$ radians

49. The relationship between I_{rms} and I_{max} in an ac circuit is
- A. $I_{rms} = 0.707 I_{max}$
 - B. $I_{max} = 0.707 I_{rms}$
 - C. $I_{rms} = 0.5 I_{max}$
 - D. $I_{max} = 0.5 I_{rms}$
50. The efficiency of a heat engine that absorbs 2000 J of energy from a hot reservoir and exhausts 1500 J to a cold reservoir is
- A. 35%
 - B. 20%
 - C. 25%
 - D. 15%
51. Which one of the following is NOT a point defect
- A. Vacancy
 - B. Interstitial atom
 - C. Anti-site
 - D. Stacking faults
52. Which one of the following $\{hkl\}$ planes does not produce constructive interference during X-ray diffraction of a face centered cubic crystal
- A. $\{113\}$
 - B. $\{211\}$
 - C. $\{440\}$
 - D. $\{555\}$
53. Which one of the following techniques can NOT be used to determine the orientation of a single crystal
- A. Powder X-ray diffraction
 - B. Laue X-ray diffraction
 - C. Precision electron diffraction in TEM
 - D. Laue synchrotron x-ray diffraction
54. Resilience refers to
- A. area under the plastic region of a stress-strain curve
 - B. area under the elastic region of a stress-strain curve
 - C. area under the linear portion of a creep curve
 - D. area under the non-linear portion of a creep curve

55. Endurance limit is obtained from
- A. Tensile test
 - B. Impact test
 - C. Creep test
 - D. Fatigue test
56. The number of congruent melting points in a eutectic phase diagram is
- A. 0
 - B. 1
 - C. 2
 - D. 3
57. Stress concentration in the vicinity of defects
- A. Leads to increase in ductility by the closure of defects
 - B. Increases the activation barrier for defect growth
 - C. Causes failure at stresses lower than theoretical values
 - D. Delay fracture through strain softening
58. Which one of the following methods cannot be used to increase the fracture toughness of ceramics
- A. Phase transformation
 - B. Crack bridging
 - C. Crack deflection
 - D. None of the above
59. Bernoulli's equation is valid for the following type of flow:
- A. Compressible, steady, in-viscous
 - B. Incompressible, steady, viscous
 - C. Compressible, unsteady, viscous
 - D. Incompressible, unsteady, in-viscous
60. Which of the following is NOT correct?
- A. Dislocations are thermodynamically unstable defects.
 - B. Dislocations can move inside a crystal under the action of an applied stress.
 - C. Screw dislocations can change the slip plane without climb
 - D. Burger's vector of an edge dislocation is parallel to the dislocation line.

61. Which one of the following metals is commonly alloyed with iron to improve its corrosion resistance?
- A. Co
 - B. Cr
 - C. Ti
 - D. Nb
62. The walls of a hall for organizing music concerts are covered with wood to
- A. Amplify sound
 - B. Reflect sound
 - C. Absorb sound
 - D. Transmit sound
63. The velocities of light v_{water} , v_{glass} , and v_{diamond} in water, glass and diamond respectively are in the following order,
- A. $v_{\text{water}} > v_{\text{glass}} > v_{\text{diamond}}$
 - B. $v_{\text{diamond}} > v_{\text{glass}} > v_{\text{water}}$
 - C. $v_{\text{diamond}} > v_{\text{water}} > v_{\text{glass}}$
 - D. $v_{\text{water}} > v_{\text{diamond}} > v_{\text{glass}}$
64. A surface that reflects all the incident radiation appears
- A. Yellow
 - B. White
 - C. Black
 - D. Red
65. Crack initiation is essentially a surface phenomenon in
- A. Fatigue
 - B. Creep
 - C. Compression failure
 - D. Tensile testing
66. A family of directions is represented by
- A. (hkl)
 - B. $\langle uvw \rangle$
 - C. $\{hkl\}$
 - D. $[uvw]$
67. Which of the following are thermodynamically stable defects
- A. Point defects
 - B. Line defects
 - C. Surface defects
 - D. Volume defects

68. Diffusion can occur in _____ materials.

- A. Solid
- B. Liquid
- C. Gaseous
- D. All

69. In a steel, during carburization at 937°C , 0.6% carbon is found at a depth of 0.2 mm after 1 hr. The time required to get 0.6% C at double this depth at the same temperature is

- A. 60 s
- B. 1.414 hr
- C. 2 hr
- D. 4 hr

70. Miller indices of the line of intersection of (111) and (110) are

- A. [110]
- B. [101]
- C. [10-1]
- D. [-101]

71. One of these is an extensive property

- A. Density
- B. Heat Capacity
- C. Specific Heat Capacity
- D. Specific gravity

72. Ellingham diagrams are schematic representation between

- A. ΔH vs P
- B. ΔG vs P
- C. ΔG vs T
- D. ΔH vs P

73. An isochoric process occurs at

- A. Constant pressure
- B. Constant volume
- C. Constant temperature
- D. Constant energy

74. According to Stirling's approximation, $\ln X! =$

- A. $X \ln X + X$
- B. $X \ln X - X$
- C. $X^2 \ln X - X$
- D. $X^2 \ln X - X$

75. For a system with Ω configurations, Boltzmann's entropy "S" is given by

- A. $S = K_B \ln \Omega$
- B. $S = K_B \sin \Omega$
- C. $S = K_B \cos \Omega$
- D. $S = K_B \tan \Omega$