ENTRANCE EXAMINATIONS 2020
Ph.D. (Materials Engineering)

Marks: 70
Time: 2 h   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 20 objective type questions of **1.75** marks each.
   There is a negative marking of **0.5** marks for every wrong answer.
2. Part 'B: It consists of 35 objective questions of one mark each with no negative marking.
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:

$$\bigcirc A \quad \bigcirc B \quad \bigcirc C \quad \bullet$$
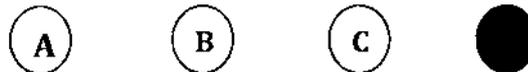
No additional sheets will be provided. Rough work can be done in the question paper itself.

4. Hand over the OMR answer sheet at the end of the examination to the invigilator.

5. Mobile phones, log tables and calculators of any type are NOT permitted inside the Examination Hall.

6. This book contains 13 pages including this cover sheet.

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PART A

1. In a given micrograph, if the length of the micron bar is 1 cm and the original dimension of a feature imaged is 100 Å, then what is the magnification at which the micrograph is recorded?

    A. 10^3
    B. 10^4
    C. 10^5
    D. 10^6

2. If in a frequency distribution the mid value of a class is 65 and the class size is 10, then the lower limit of the class is

    A. 32.5
    B. 55.0
    C. 60.0
    D. 10.0

3. If $\int_{-\infty}^{\infty} e^{-x^2}\, dx = \sqrt{\pi}$, then $\int_{-\infty}^{\infty} a e^{-(x-b)^2/(2c^2)}\, dx = ?$

    A. $a/c\,\sqrt{2\pi}$
    B. $ac\,\sqrt{2\pi}$
    C. $c/a\,\sqrt{2\pi}$
    D. $\sqrt{2\pi}$

4. When $f(x)$ is given at distinct tabular points of x, i.e., at $x_1, x_2, \ldots, x_n$, it can be approximated to a polynomial of degree

    A. $= n$
    B. $> n$
    C. $\geq n$
    D. $\leq n - 1$

5. The velocity v (in ms^{-1}) of a body is given by v = 2t^2 +5, where t is time in s. How far (in m) it moves in the time interval from t = 0 to t = 4s?

    A. 63 m
    B. 51 m
    C. 77 m
    D. 48 m

6. If two alloys A and B contain Cu and Ni in the ratios of 2:3 and 3:7 by mass, respectively, then what is the ratio of Cu to Ni in an alloy C made by melting equal masses of alloy A and B?

   A. 7:13
   B. 5:16
   C. 3:8
   D. 7:15

7. In a tug of war game an equilibrium condition exists. Both the teams pull the rope with a force of 10^5 N. What is the tension in the rope?

   A. 10^4 N
   B. 10^5 N
   C. 0 N
   D. 2×10^5 N

8. A bullet of mass 20 g is fired from a rifle of 10 kg with a velocity of 100 ms^{-1}. The recoil velocity of the rifle is?

   A. 0.20 ms^{-1}
   B. 25 ms^{-1}
   C. 2.5 ms^{-1}
   D. 250 ms^{-1}

9. If $\bar{m}$ and $\bar{n}$ are two arbitrary vectors with magnitudes m and n, respectively, then $|\bar{m} \times \bar{n}|^2$ will be equal to?

   A. $m^2 n^2 - (\bar{m}.\bar{n})^2$
   B. $mn - \bar{m}.\bar{n}$
   C. $m^2 n^2 + (\bar{m}.\bar{n})^2$
   D. $mn + \bar{m}.\bar{n}$

10. What is the work done in holding 25 kg suitcase while waiting for a bus for 45 minutes?

    A. 675 Joule
    B. 40500 Joule
    C. 4500 Joule
    D. 0

11. The first and second derivatives of a quadratic polynomial at x =1 are 1 and 2, respectively. Then the value of f(1) - f(0) is?

    A. 3/2
    B. 0
    C. 1/2
    D. 1

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12. The curvature of the function $f(x) = x^2+2x+1$ at $x = 0$ is?

    A. $|3/2|$
    B. $|5/2|$
    C. $|2/5^{3/2}|$
    D. $|5/2^{3/2}|$

13. If the number of cases of persons affected by COVID-19 is doubling every 4 days and 20 days after the recording of cases started, the number was 1,16,800, then the number of cases on the day when the calculation started is?

    A. 23,360
    B. 11,680
    C. 5,840
    D. 3,650

14. The chance of a student passing an exam is 50%. The chance of the student passing the exam and getting above 75% marks is 5%. Given that the student passes the examination, the probability that the student gets above 75% marks is

    A. 1/10
    B. 1/9
    C. 1/7
    D. 1/5

15. The general value of log $(-i)$ is,

    A. $i\pi$
    B. $(-i\pi/2)+ 2\pi n$, where 'n' is an integer
    C. $-i[(\pi/2) + 2\pi n]$, where 'n' is an integer
    D. $i[(-\pi/2) + 2\pi n)]$, where 'n' is an integer

16. A force of 4 N produces a change in momentum of 0.8 kg ms^{-1} in a body of mass 1 kg. The time over which this momentum is produced is?

    A. 0.2 s
    B. 0.02 s
    C. 0.5 s
    D. 0.05 s

17. The engine of a car produces an acceleration of 8 ms^{-2} in the car, if this car pulls another car of same mass, what is the acceleration produced?

    A. 8 ms^{-2}
    B. 2 ms^{-2}
    C. 4 ms^{-2}
    D. 0.5 ms^{-2}

18. Six girls A, B, C, D, E and F are marching in a line. They are arranged according to their height, the tallest being at the back and the shortest in the front. F is between B and A. E is shorter than D but taller than C who is taller than A. E and F have two girls between them. A is not the shortest among them. Where is E positioned?

    A. Between A and B
    B. Between C and A
    C. Between D and C
    D. In front of C

19. A ball of mass 1 kg and another of mass 2 kg are dropped together from a 100 ft tall building. After a fall of 50 ft each towards earth, their respective kinetic energies will be in the ratio of?

    A. $\sqrt{2}:1$
    B. 1:4
    C. 1:2
    D. 1:$\sqrt{2}$

20. If the probability of reaching a target is 0.6., then what are mean and variance, respectively?

    A. 0.4 and 0.24
    B. 0.6 and 0.24
    C. 0.4 and 0.16
    D. 0.6 and 0.16

PART B

21. If 10 molecular percent of Zn ferrite is added to Ni ferrite to prepare (Ni, Zn) mixed ferrite, then what is the expected net magnetic moment per molecule of the (Ni, Zn) mixed ferrite?

   A. 2.0 μ_B
   B. 2.8 μ_B
   C. 0.8 μ_B
   D. 1.8 μ_B

22. In a dielectric solid, the slowest relaxation occurs for

   A. Electronic polarization
   B. Ionic polarization
   C. Dipolar polarization
   D. Space charge polarization

23. Which of the following is true with regards to thermodynamics and kinetics of a process?

   A. When a process is thermodynamically feasible, it is always suppressed kinetically
   B. When a process is thermodynamically feasible, it may be suppressed kinetically
   C. When a process is not thermodynamically feasible, it may be feasible kinetically
   D. When a process is not thermodynamically feasible, it is always feasible kinetically

24. Which of the following is used in visual inspection of the inside of a tube?

   A. Inverted microscope
   B. Flexiscope
   C. Endoscope
   D. Boroscope

25. What are the coordinates in Phase diagrams of metallic materials?

   A. Composition and temperature
   B. Composition and partial pressure
   C. Temperature and pressure
   D. Temperature and volume

26. Which of the following least affects the peak position in a X-ray diffractogram?

    A. X-ray wavelength
    B. Crystallite size
    C. Unit cell parameter
    D. Strain

27. What is the function for which the Taylor series expansion about $x = 0$ is given by, $x^3 - [(x^3)^3/3!] + [(x^3)^5/5!] - [(x^3)^7/7!]$?

    A. $\sin^3 x$
    B. $\cos^3 x$
    C. $\sin(x^3)$
    D. $\cos(x^3)$

28. Which one of the following is nonmagnetic phase at room temperature?

    A. Austenite
    B. Martensite
    C. Bainite
    D. Ferrite

29. Which of the following processes can be used as an alternative technique for joining aluminum and its alloys?

    A. Tungsten inert-gas welding
    B. Metal inert-gas welding
    C. Friction stir welding
    D. Oxy-acetylene flame technique

30. A potential of 20 V is applied across a parallel plate capacitor with plate area of 5×10^{-4} m² and plate separation of 2×10^{-3} m. If a material with dielectric constant of 10 is inserted into the region within the plates, the polarization induced in the material is (permittivity of free space = 8.85×10^{-12} F/m)?

    A. 9.76×10^{-7} C/m²
    B. 6.97×10^{-7} C/m²
   C. 8.69×10^{-7} C/m²
    D. 7.96×10^{-7} C/m²

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31. A vertical pipe contains a stationary incompressible fluid of density ρ. If the pressure at a point $h = 0$ is P_0, then the pressure at a depth h, below $h = 0$ is (g is acceleration due to gravity)

   A. $P_0 + \rho gh$
   B. $P_0 - \rho gh$
   C. ρgh
   D. P_0

32. The ability of a material to resist plastic deformation can be judged by determining its

   A. Tensile strength
   B. Yield strength
   C. Modulus of elasticity
   D. Impact strength

33. Addition of Zn to Cu improves the creep resistance of Cu because

   A. Zn increases the elastic modulus of Cu
   B. Zn increases the melting point of Cu
   C. Zn reduces the stacking fault energy of Cu
   D. Zn increases the grain size of Cu

34. A Frenkel defect is the simultaneous occurrence of a

   A. Positive-ion interstitial and a negative-ion vacancy
   B. Positive-ion interstitial and a positive-ion vacancy
   C. Positive-ion vacancy and a negative-ion vacancy
   D. Positive-ion vacancy and a negative-ion interstitial

35. The recrystallization temperature of a given alloy depends on its

   A. Purity
   B. Density
   C. Melting point
   D. Grain size

36. In an electropolishing process, material removal happens by

   A. Anodic dissolution
   B. Cathodic dissolution
   C. Chemical corrosion
   D. Mechanical erosion

37. What is the map of reciprocal lattice of a crystal?

    A. High resolution microscopic image of the crystal
    B. Image of the crystal's diffraction pattern
    C. Compositional image of the crystal
    D. High resolution cohesive energy distribution image of the crystal

38. The most dense crystallographic plane in a Cu crystal would be

    A. (112)
    B. (111)
    C. (123)
    D. (110)

39. If the units of Celsius and Kelvin scales are equal, then what will be the freezing temperature of H_2O at atmospheric pressure?

    A. 273.15 K
    B. -273.15 K
    C. 273.15 °C
    D. -273.15 °C

40. The degree of sensitization of a stainless steel weldment can be quantitatively determined by

    A. Potentiostatic testing
    B. Galvanostatic testing
    C. Electrochemical potentiodynamic reactivation technique
    D. Open circuit potential measurement

41. The bandgap of a semiconducting nanomaterial is

    A. Always zero
    B. Lower than the corresponding bulk material
    C. Same as the corresponding material
    D. Higher than the corresponding bulk material

42. Which of the following results in increase in pile up of dislocations?

    A. Decrease in stacking fault energy
    B. Increase in stacking fault energy
    C. Increase in grain size
    D. Increase in temperature

43. Which of the following techniques can be used to detect incomplete fusion in a thick welded region?

    A. Liquid penetrant test
    B. Magnetic particle inspection
    C. Radiography
    D. Eddy current testing

44. The analysis of the fractograph of an aircraft wing confirmed that it had fractured due to fatigue. Which of the following features on the fractograph can lead to such a conclusion?

    A. Striations
    B. Dimples
    C. Voids
    D. Crack branching

45. A differential scanning calorimetry scan of a semi-crystalline polymer is expected to display

    A. Only glass transition temperature
    B. Both glass transition and crystalline melting temperatures
    C. Only crystalline melting temperature
    D. Either glass transition temperature or crystalline melting temperature

46. Which of the following crystallographic directions in pure iron is the easiest direction of magnetization?

    A. <111>
    B. <100>
    C. <110>
    D. <112>

47. Which of the following is not an example of an inelastic collision?

    A. A cricket bat striking a ball
    B. A collision between two billiard balls
    C. A bullet embedded in a human body
    D. Electrons with energy greater than a critical value colliding with a Hg atom

48. Rusting of iron reinforcements inside concrete structures occurs naturally in humid environment because

    A. It leads to decrease in Gibbs free energy
    B. It leads to increase in Gibbs free energy
    C. It leads to decrease in enthalpy
    D. It leads to increase in enthalpy

49. Under a constant applied electric field, the drift velocity of the electron increases if

    A. Mobility of the electrons is constant
    B. Mobility of the electrons is zero
    C. Mobility of the electrons decreases in the material
    D. Mobility of the electrons increases in the material

50. In the following figure the zone of stress corrosion cracking (SCC) is indicated by
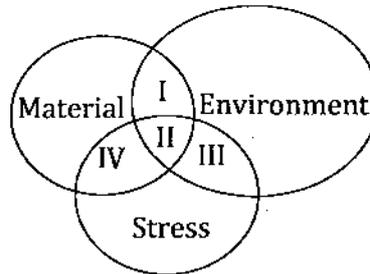
    A. I
    B. II
    C. III
    D. IV

51. Where does the solidification start in a relevant phase diagram?

    A. At equilibrium
    B. Solidus line
    C. Liquidus line
    D. At freezing point

52. During melting process, flux is added to react with impurities to form

    A. Cavity
    B. Slag
    C. Cold shut
    D. Blow holes

53. The viscosity of a gas is

    A. Independent of pressure and increases with temperature
    B. Dependent on pressure and decreases with temperature
    C. Independent of pressure and decreases with temperature
    D. Dependent on pressure and increases with temperature

54. Which one of the following factors would not affect the ultimate tensile strength of a metal significantly?

A. Grain size
B. Melting temperature
C. Dislocation density
D. Atomic weight of the element constituting the metal

55. An Arrhenius type of plot is used for determining the activation energy of deformation. This plot is generally

A. A log-log plot between applied stress on x-axis and temperature on y-axis
B. A semi-log plot between reciprocal of stress on x-axis and log of creep strain rate on y-axis
C. A semi-log plot between reciprocal of temperature on x-axis and log of creep strain rate on y-axis
D. A log-log plot between applied stress on x-axis and creep strain rate on y-axis

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