

V-91

**ENTRANCE EXAMINATIONS – 2019**  
**(Ph.D.Admissions - January 2020 Session)**

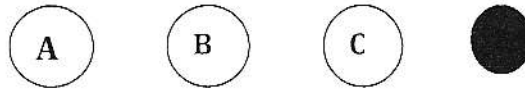
Ph.D. (Materials Engineering)

Marks: 70  
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 20 questions of **1.75**marks each.  
There is a negative marking of **0.50** marks for every wrong answer.
2. Part 'B': It consists of **35** 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:



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 12 pages including this cover sheet.

**PART A**

1. Which one of the following elements does not form an amalgam?
  - A. Zn
  - B. Fe
  - C. Cu
  - D. Mg
  
2. Which one of the following correlations is correct?
  - A. Wavelength: Angstrom
  - B. Electric Charge: Ampere
  - C. Electric Resistance: Coulomb
  - D. Momentum: Joule
  
3. A square shaped swimming pool (2m x 2m x 1m) has to be renovated into a circular swimming pool having the same depth (1 m). If the diameter of the circle equals the diagonal of the square, the volume of the earth required be removed is
  - A.  $(2\pi - 4) \text{ m}^3$
  - B.  $(4\pi - 4) \text{ m}^3$
  - C.  $(4\pi - 2) \text{ m}^3$
  - D.  $(2\pi - 2) \text{ m}^3$
  
4. The derivative of a function  $f(x,y)=x^2+y$  at the point (1,1) along the direction given by  $\vec{v}=\hat{i}+2\hat{j}$  is (here  $\hat{i}$  and  $\hat{j}$  are unit vectors)
  - A. 3
  - B. 4
  - C. 2
  - D. 1
  
5. The matrix realization of a linear operator on a 3-dimensional vector space in a basis( $e_1, e_2, e_3$ ) is given by  $A = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & -1 \\ 0 & 1 & 2 \end{pmatrix}$  : This linear operator action on a vector  $x = 2e_1 + 3e_2 + e_3$  results in:
  - A.  $2e_1 + 3e_2 + e_3$
  - B.  $2e_1 + 5e_2 + 3e_3$
  - C.  $2e_1 + 5e_2 + 5e_3$
  - D.  $5e_1 + 5e_2 + 2e_3$
  
6. Laplace transform of  $e^{-\alpha t} \cos \beta t$  is
  - A.  $\beta / [\beta^2 + (s + \alpha)^2]$
  - B.  $(s + \alpha) / [\beta^2 + (s + \alpha)^2]$
  - C.  $\frac{\beta - \alpha}{[(\beta - \alpha)^2]} + s^2$
  - D.  $(s - \alpha) / [\beta^2 + (s - \alpha)^2]$

7. The residue of  $f(z) = 1/[(z^2 - 25)(z + 1)]$  at  $z = +5$  and  $-1$  are
- $-1/60, -1/24$
  - $1/60, 1/24$
  - $1/60, 1/60$
  - $1/60, -1/24$
8. The number of electrons present in  $H^+$  is
- 2
  - 1
  - 0
  - 3
9. The most electronegative element among the following is
- S
  - Br
  - F
  - O
10. Which one of the following is the correct electronic configurations for  $K^+$
- $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
  - $1s^2 2s^2 2p^6 3s^2 3p^6$
  - $1s^2 2s^2 2p^6 3s^2 3p^5 4s^2$
  - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
11. The only possible shape for a  $sp^3$  hybridized central atom is
- Linear
  - Tetrahedral
  - Trigonal planar
  - Trigonal pyramidal
12. If the crystal structure and all diffraction parameters are the same, then which of the relations is true for the intensity of (111) diffraction planes in NaCl and AgCl
- Intensity in the case of NaCl > Intensity in the case of AgCl
  - Intensity in the case of NaCl = Intensity in the case of AgCl
  - Intensity in the case of AgCl > Intensity in the case of NaCl
  - Intensity in both NaCl and AgCl = 0
13. At room temperature the occupation number of an electron state lying above the Fermi level is always
- zero
  - same as that of an electron state lying below the Fermi level
  - lower than that of an electron state lying below the Fermi level
  - greater than that of an electron state lying below the Fermi level

14. The necessary and sufficient condition for superconductivity to occur in a material is that
- Resistance should drop to zero below a certain temperature
  - Magnetic field should be expelled below a certain temperature
  - Material should be an insulator
  - Both A and B should be satisfied
15. If the wave function  $\Psi$  representing a moving particle is given by  $\Psi = M \exp(-mx) \forall 0 < x < \infty$  and  $\Psi = 0 \forall -\infty < x < 0$ , then the value of  $M$  is?
- $\sqrt{2m}$
  - $m\sqrt{2}$
  - $2\sqrt{m}$
  - $2m$
16. Assume that life has existed on the surface of the moon without changing its present acceleration due to gravity. 5 kg weight of sugar is prepared on the earth and carried to the moon. If, from 100 grams of sugar 10 cups of tea can be made on the moon surface, 5 kg sugar can make. (Assume  $g$  on Earth is  $10\text{m}^2/\text{s}$ )
- 0 cup of tea
  - 50 cups of tea
  - 500 cups of tea
  - 3000 cups of tea
17. Four forces are acting on a rigid body resting on a plane. For the body to not change its position or shape the forces must
- be of equal magnitude
  - add up to zero
  - be of parallel and opposite
  - be in a simple line
18. If  $a^{1/x} = b^{1/4} = c^{1/z}$  and  $b^z = ac$ . The value of  $x+z/y$  is
- $1/4$
  - $1/2$
  - 1
  - 2
19. Which mechanical property will be adversely affected during tempering embrittlement?
- Impact Strength
  - Hardness
  - Tensile Strength
  - Yield Strength

20. Given an arbitrary complex number  $z$ ,  $\arg(z) - \arg(z^*)$  is
- A. 0
  - B.  $\theta$
  - C.  $2\theta$
  - D.  $-2\theta$

**PART B**

21. The element that can crystallize in simple cubic structure is
- Po
  - Pu
  - Th
  - U
22. Fe transforms from BCC to FCC structure at  $910^{\circ}\text{C}$ . If, at this temperature the atomic size (radii) of the Fe atom in BCC and FCC structures are  $1.258\text{\AA}$  and  $1.292\text{\AA}$  respectively, then the unit cell volume due to structural transformation
- increases by a factor of  $(1.258\text{\AA})^3$
  - decreases
  - does not change
  - increases by a factor of  $(1.292\text{\AA})^3$
23. A sample of graphene has a large number of oxygen impurities. The best technique to image these impurities is
- Field Emission Scanning Electron Microscopy
  - High Resolution Transmission Electron Microscopy
  - Atomic Force Microscopy
  - Optical Microscopy
24. Which of the following techniques is best suited to map trapped charges on a dielectric surface?
- Electric Force Microscopy
  - Scanning Tunneling Microscopy
  - Magnetic force Microscopy
  - Electrochemical Atomic Force Microscopy
25. The spatial resolution in Scanning Electron Microscopy at a given energy, depends mainly on the
- spot size of the electron beam
  - wavelength of the electrons
  - coil current
  - shape of the electrons
26. The work function of a metal can be expressed in terms of
- density of electrons in the metals
  - Helmholtz free energy of the electrons in the metal
  - Gibbs free energy of the electrons in the metals
  - volume of electron gas in the metal

27. When ice at 273 K melts to become water at 273K, it's entropy is
- A. lower
  - B. unchanged
  - C. zero
  - D. higher
28. If a spherical optical lens has chromatic aberration, then considering red, blue and green wavelengths
- A. the focal point on the optical axis is the farthest from the lens for blue light
  - B. the focal point on the optical axis is the farthest from the lens for green light
  - C. a focal point on the optical axis is the nearest from the lens for green light
  - D. the focal point on the optical axis is the farthest from the lens for red light
29. The property of a given material to exist in two or more crystalline structures is known as
- A. Isomerism
  - B. Multimorphism
  - C. Polymorphism
  - D. Isomorphism
30. The shape of the first Brillouin zone of an FCC lattice is
- A. Tetrahedral
  - B. Trigonal
  - C. Truncated Hexagon
  - D. Truncated Octahedron
31. Thermal conductivity is measured in units of
- A. watt per kelvin meter
  - B. watt kelvin meter
  - C. kelvin per watt meter
  - D. meter per kelvin watt
32. If  $N_C$  is the effective density of states and  $N_D$  the concentration of donor atoms, then for a n-type semiconductor the position of the Fermi level is proportional to
- A.  $N_C/N_D$
  - B.  $N_D/N_C$
  - C.  $\log(N_C/N_D)$
  - D.  $N_C \log(N_D)$

33. The creep rate behavior at high temperature, where the bulk diffusion is greater than the grain boundary diffusion, is best described by
- Coble creep
  - Nabarro-Herring creep
  - viscous creep
  - dislocation creep
34. Monkman and Grant equation is linked to
- lifetime prediction during fatigue
  - lifetime prediction during corrosion
  - lifetime prediction during creep
  - lifetime prediction during sub critical crack growth
35. The time dependent polarization decay in dielectrics is described by
- Clausius-Mosotti relation
  - Debye relation
  - Einstein relation
  - Kramers- Kronig relation
36. The inverse susceptibility of an ideal paramagnetic substance
- decreases with temperature
  - increases with temperature
  - first increases then decreases with temperature
  - first decreases then increases with temperature
37. The activity coefficient of defects in solids is best described by
- Kroger-Vink theory
  - Debye-Huckel theory
  - Braouwer theory
  - Schottky theory
38. The transformation toughening of Zirconia toughened Alumina ceramic matrix composites is predominantly due to
- retention of Monoclinic and Cubic phase at ambient condition
  - retention of Cubic phase at ambient condition
  - retention of Tetragonal and Cubic phases at ambient condition
  - retention of Tetragonal phase at ambient condition
39. Rubber Latex is an example of a
- dilatant fluid
  - Newtonian fluid
  - pseudoplastic fluid
  - Bingham plastic



40. In a Biot number, the characteristic length used is the ratio of
- perimeter to surface area of solid
  - surface area to volume of the solid
  - surface area to perimeter of the solid
  - volume to surface area of the solid
41. A Solenoid valve is an example of a
- Pneumatic valve
  - Electropneumatic valve
  - Mechanical valve
  - Electromechanical valve
42. Milk is dried usually in a
- freeze dryer
  - spray dryer
  - tray dryer
  - rotary dryer
43. For Piezoelectric Transducers
- high  $d$  coefficients are desirable
  - high  $g$  coefficients are desirable
  - low  $d$  coefficients are desirable
  - low  $g$  coefficients are desirable
44. The ferromagnetism of  $\text{Cu}_2\text{MnSn}$  crystal which belongs to the class of Heusler alloys is primarily due to
- large Cu-Cu distance
  - large Sn-Sn distance
  - large Mn-Mn distance
  - large Cu-Mn distance
45. Griffith's criterion is valid for
- brittle material
  - ductile material
  - any metal
  - porous materials only
46. Constitutional super cooling is observed in
- forging
  - extrusion
  - rolling
  - casting
47. Which of the following metal forming operations involves plane strain compression?
- cold rolling
  - wire drawing
  - stretch forming
  - extrusion

48. When a buried pipeline is protected from corrosion by connecting it to Magnesium block it is called
- impressed current protection
  - impressed voltage protection
  - sacrificial cathodic protection
  - sacrificial anodic protection
49. Peierls-Nabarro stress represents the resistance within the crystalline lattice for the movement of
- dislocations
  - impurities
  - grain boundaries
  - interstitial atoms
50. Carbon content is high in martensitic stainless steels to
- increase wear strength only
  - increase hardness only
  - decrease hardness and increase wear strength
  - increase hardness and wear strength
51. Which of the following defects exist in thermodynamic equilibrium above "0" K.
- line defect
  - surface impurities
  - vacancies
  - surface cracks
52. If  $T_R$  = Recrystallisation temperature and  $T_M$  = melting temperature, then in pure metals
- $T_R = 0.2T_M$
  - $T_R = 0.3T_M$
  - $T_R = 0.4T_M$
  - $T_R = 0.7T_M$
53. Austenite phase formation in the Iron-Carbon phase diagram is due to
- eutectic reaction
  - eutectoid reaction
  - peritectoid reaction
  - peritectic reaction
54. High angle grain boundaries and low angle grain boundaries are separated by a misorientation angle of
- $15^\circ$
  - $30^\circ$
  - $45^\circ$
  - $60^\circ$

55. The maximum number of independent slip systems necessary for plastic deformation in metals with BCC crystal structure is
- A. 12
  - B. 24
  - C. 36
  - D. 48