ENTRANCE EXAMINATIONS, 2015
QUESTION PAPER

Ph. D. (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:

$$\text{(A)} \qquad \text{(B)} \qquad \text{(C)} \qquad \bullet$$

   No additional sheets will be provided. Rough work can be done in the question paper itself and rough work sheets provided at the end of the booklet.

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.

SECTION-A

1. The relative orientation of Burgers vector and the dislocation line for mixed type dislocation is

     A. Perpendicular
     B. Parallel
     C. Both Perpendicular and Parallel
     D. Neither perpendicular nor parallel

2. For a linear molecule having N number of atoms, the number of possible vibrational motion is

     A. 3N-6
     B. 3N
     C. 3N-5
     D. None of the above

3. Duringoverageing, hardness

     A. Decreases
     B. Increases
     C. Is constant
     D. Increases abruptly

4. The capacitance of an isolated spherical conductor of radius R and charge Q is

     A. $\frac{4\pi}{\varepsilon_0 R}$

     B. $4\pi\varepsilon_0 R$

     C. $\frac{4\pi\varepsilon_0}{R}$
     D. None of the above

5. The energy corresponding to highest filled state for a metal at 0 K is

     A. Band gap energy
     B. Fermi energy
     C. Bothe A and B
     D. None of the above

6. Gibbs Phase rule is

     A. F = C– P+2
     B. F = P-C+2
     C. F = C+P-2
     D. F = C-P-1

J-89

7. Increasing the grain size of an alloy improves which of the following properties

A. Creep strength
B. Yield strength
C. Ultimate tensile strength
D. Fatigue resistance

8. Mostly salt of transition metals are

A. Colored
B. White
C. Liquid
D. Semisolid

9. A cation vacancy and an anion vacancy in a crystal of the type AB is called

A. Schottky defect
B. Frenkel defect
C. Pair of vacancy
D. None of the above

10. In case of simple harmonic motion, displacement is proportional to

A. Velocity
B. Acceleration
C. Both A and B
D. Neither A nor B

11. Pure Si at 0 K is an

A. Intrinsic semiconductor
B. Extrinsic semiconductor
C. Metal
D. Insulator

12. When a tuning fork vibrates the waves produced in the fork are

A. Stationary
B. Longitudinal
C. Progressive
D. Transverse

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13. The dimensional formula of Bulk Modulus of Elasticity is same as that of

    A. Pressure
    B. Density
    C. Force
    D. None of these

14. Thermal expansion in solids with increasing temperature is a consequence of

    A. Anharmonicity of the lattice vibration
    B. Pressure of the electron gas
    C. Dislocations in the lattice
    D. None of the above

15. The origin of van der Waals interaction in molecular crystals is

    A. Nuclear
    B. Magnetic
    C. Ionic
    D. Fluctuating dipole

16. Magnetic field of an infinitely long ideal solenoid of radius R carrying current I,

    A. Increase radially inside and zero outside the solenoid
    B. Is constant inside and zero outside the solenoid
    C. Is constant inside and decays as I r outside the solenoid
    D. Is constant inside and decays as exp(-1/r) outside

17. The cyclic stress-strain curve is represented by:

    A. $\Delta\sigma = K^1 (\Delta\varepsilon_p)^{n1}$

    B. $\Delta\sigma = n^1 (\Delta\varepsilon_p)^{K1}$

    C. $\Delta\varepsilon_p = K^1 (\Delta\sigma)^{n1}$

    D. $\Delta\varepsilon_p = n^1 (\Delta\sigma)^{K1}$

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18. For enhanced fatigue life,

    A. Material with fine grain size is required

    B. Material with compressive residual stresses is required

    C. Both A and B

    D. None of these

19. For high temperature applications, a material should have:

    A. Fine grain size alone

    B. Coarse grain size alone

    C. Fine grain size and fine second phases pinning the grain boundaries

    D. Coarse grain size and fine second phase precipitates pinning the grain boundaries

20. Izod test is used to measure:

    A. Shear strength

    B. Impact strength

    C. Tensile strength

    D. Compressive strength

21. If r_A and r_B are the atomic radii of A and B respectively, then A and B will form a solid solution when

    A. $|r_A - r_B| > 15\,\%$

    B. $|r_A - r_B| < 15\,\%$

    C. $|r_A + r_B| < 15\,\%$

    D. $|r_A + r_B| > 15\,\%$

22. Dislocations in metals are characterized by

    A. Etch-pitting

    B. Transmission Electron Microscopy

    C. Both A and B

    D. None of these

23. The equilibrium defects are

    A. Dislocations

    B. Vacancies

    C. Stacking faults

    D. Cracks

24. Gay Lussac's law gives the relationship between:

    A. Volume and temperature at constant pressure

    B. Pressure and temperature at constant volume

    C. Pressure and volume at constant temperature

    D. Free energy and entropy at constant internal energy

25. Units of Diffusion Coefficient are:

    A. No units

    B. m^2/sec

    C. N/m^2

    D. N/sec^2

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SECTION-B

26. The wavelength of the electromagnetic radiation required for electronic transition between two electronic states of energy difference of 5eV is

    A. 200 nm
    B. 300 nm
    C. 250 nm
    D. 150 nm

27. A 0.050 kg ingot of metal is heated to 200 °C and then dropped into a beaker containing 0.400 kg of water (specific heat of water is 4186 J/kg. C) initially at 20 °C. If the final equilibrium temperature of the mixed system is 24 °C, find the specific heat of the metal?

    A. 761 J/kg. °C
    B. 435 J/kg. °C
    C. 782 J/kg. °C
    D. 456 J/kg. °C

28. Which is true for entropy change of a system that undergoes a reversible adiabatic process

    A. $\Delta S > 0$
    B. $\Delta S < 0$
    C. $\Delta S = 0$
    D. All the above true

29. The at. wt % of copper in a Cu-Al alloy that consists of 97 weight % of Al and 3 weight % Cu is (density of Al: 2.7 g/cc; density of Cu: 8.9 g/cc)

    A. 1.30 at%
    B. 2.55 at%
    C. 1.56 at%
    D. 2.34 at%

30. The principal sub- matrix of $M = \begin{vmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 9 & 10 & 11 & 12 \\ 13 & 14 & 15 & 16 \end{vmatrix}$

A. $\begin{bmatrix} 9 & 10 \\ 13 & 14 \end{bmatrix}$

B. $\begin{bmatrix} 3 & 4 \\ 7 & 8 \end{bmatrix}$

C. $\begin{bmatrix} 6 & 7 \\ 10 & 11 \end{bmatrix}$

D. M cannot have a principal sub-matrix

31. For a fluid in equilibrium under an external force $\vec{F}$

A. $\vec{F} \cdot (\vec{\nabla} \times \vec{F}) = 0$
B. $\vec{F} \times (\vec{\nabla} \times \vec{F}) = 0$
C. $\vec{F} \cdot (\vec{\nabla} \times \vec{F}) = 1/2$
D. $\vec{F} \times (\vec{\nabla} \times \vec{F}) = 1/2\vec{F}$

32. If ω is the angular frequency of the applied electric field, the power loss in a dielectric is proportional to

A. $\frac{1}{\omega^2}$

B. $\frac{1}{\omega}$

C. ω^2

D. ω

33. Structure-sensitive property of a superconductor is

A. Critical temperature, T_C

B. Critical current density, J_C

C. Critical magnetic field, H_C

D. All of the above

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34. Electrons are accelerated by 300V (wavelength = 0.07nm) and are reflected from a crystal. The first reflection maximum occurs when the angle of incidence is 60°. What is the inter-planar spacing in the crystal?

    A. 0.060nm
    B. 0.050nm
    C. 0.040nm
    D. 0.030nm

35. The heat generated in the target of an X-ray tube is 200J/sec. How much power is radiated if the efficiency is 0.4%?

    A. 0.8 Watt
    B. 0.4Watt
    C. 0.2Watt
    D. 0.1Watt

36. If 'v' is the non-relativistic kinetic energy of particles of mass 'm', 'θ' is the diffraction angle, 'd' is the inter-planar spacing, 'h' is the Planck's constant and 'n' is the order of diffraction, Bragg's law can be written as

    A. $\sin \theta = \dfrac{nh}{2d(2mv)^{3/2}}$

    B. $\sin \theta = \dfrac{nh}{2d(2mv)^{1/2}}$

    C. $\sin \theta = \dfrac{nh}{4mdv}$

    D. $\sin \theta = \dfrac{nh}{2mdv}$

37. If 'c' is the height of a hcp unit cell and 'a' is the nearest neighbor distance, What is the volume of the hcp unit cell

    A. $\dfrac{2\sqrt{2}a^2c}{2}$

    B. $\dfrac{2\sqrt{3}a^2c}{2}$

    C. $\dfrac{3\sqrt{2}a^2c}{2}$

    D. $\dfrac{3\sqrt{3}a^2c}{2}$

38. The order of the modulus tensor is

    A. Two
    B. Three
    C. Four
    D. One

39. In Mohr's circle, the angle between the directions of principal normal stress and the principal shear stress is

    A. 90°
    B. 45°
    C. 60°
    D. 0°

40. Ductile- brittle transition is seen in _____ materials

    A. FCC
    B. LICP
    C. Orthorhombic
    D. BCC

41. Hill's theory of anisotropic plasticity assumes the following symmetry to be present in the materials

    A. Isotripic
    B. Monoclinic
    C. Hexogonal
    D. Orthotropic

42. Flash gutter in a closed-die forging die set is located at the point of _____ flow resistance.

    A. Low
    B. Inter mediate
    C. Maximum
    D. Negligible

43. 'Orange peel effect' is due to

    A. High temperature
    B. High strain rate
    C. Coarse grain size
    D. High friction

44. Cavitation in superplastic alloys can be eliminated by

    A. Increasing temperature
    B. Decreasing strain rate
    C. Decreasing grain size
    D. Applying a "back pressure"

45. Powder metallurgy superplastic alloys are costlier than those made through ingot metallurgy

    A. True
    B. False
    C. depends on the application
    D. unrelated

46. Cold rolled grain oriented steels are used to build

    A. Dams
    B. Bridges
    C. Electric transformers
    D. Window bars

47. Nickel which is to the left of Cu ($3d^{10}4s^1$) in the first transition series has an outer electron configuration of

    A. $3d^94s^1$
    B. $3d^84s^2$
    C. $3d^{11}4s^1$
    D. $3d^{10}4s^2$

48. Bauschinger effect is

    A. Hysteresis loss during loading and unloading
    B. Anelastic deformation
    C. Dependence of yield stress on path and direction
    D. None

49. Which one the following process does not happen during plastic deformation

    A. Grain boundary sliding
    B. Slip
    C. Twinning
    D. None of the above

50. Which one of the following product cannot be produced by rolling

    A. Seamless pipe
    B. I-beams
    C. Crankshaft
    D. Rails

51. Match the products in group I with the processing method in group II

Group I	Group II
P. W filament	1. Extrusion
Q. Mg single crystal	2. Deep drawing
R. Cans	3. Powder metallurgy
S. Rods	4. Czochralski method

    A. P:3   Q:4   R:2   S:1
    B. P:2   Q:4   R:1   S:3
    C. P:4   Q:3   R:2   S:1
    D. P:3   Q:2   R:4   S:1

52. If the radius of an atom in a simple cubic crystal is r, the body diagonal of the unit cell is

    A. $r\sqrt{3}$
    B. $2r\sqrt{3}$
    C. $4r/\sqrt{3}$
    D. $3r/4$

53. Minimum number of slip systems that must be operative during plastic deformation are

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

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54. For the same diffusion time, the depth of diffusion penetration at 500 °C and 850 °C is in the ratio of 1:6. The activation energy for diffusion is

    A. 57 kJ/mol
    B. 37 kJ/mol
    C. 114 kJ/mol
    D. 74 kJ/mol

55. If $D_0 = 0.00004$ m²/sec and $Q = 100$ kJ/mol, to double the depth of penetration, the initial temperature of 900 °C should be increased to

    A. 910°C
    B. 923°C
    C. 986°C
    D. 1083°C

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

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

57. If the fraction of liquid with 57% B, which is in equilibrium with a solid of 82% B, is 0.7, the overall composition is
    A. 0.3
    B. 74.5% B
    C. 64.5% B
    D. 25% B

58. Which of the following is not a suitable solid lubricant?

    A. Talc
    B. Molybdenum disulphide
    C. Graphite
    D. None of these

59. Bronze is an alloy of
    A. Cu & Zn
    B. Cu, Sn & Zn
    C. Cu & Sn
    D. Sn & Pb

60. The alloying element which can replace Tungsten in high speed steels is

    A. Nickel
    B. Vanadium
    C. Cobalt
    D. Molybdenum

61. $\lim_{x \to 2} \frac{\sin \pi x/2}{x-2}$ is

    A. $-\frac{\pi}{2}$
    B. $\frac{\pi}{2}$
    C. $-\frac{\pi}{4}$
    D. 1

62. The equation of the tangent to the ellipse $13(x^2 + y^2) - 10xy - 144 = 0$ at the point (3,3) is

    A. $y + x - 6 = 0$
    B. $y - x - 6 = 0$
    C. $y - 3x - \sqrt{2} = 0$
    D. $y + 3x - \sqrt{2} = 0$

63. Area of a triangle with sides of length 5, 6 and 7 equals

    A. $6\sqrt{6}$ units
    B. 15 units
    C. 21 units
    D. $6\sqrt{3}$ units

64. The fraction of open space in BCC materials is:

    A. 0.32
    B. 0.26
    C. 1.25
    D. 1.52

65. The properties of composite materials are often estimated using:

    A. Rule of thumb

    B. Rule of mixtures

    C. Runge-Kutta method

    D. Fleming's rule

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66. According to Rayleigh criterion (δ = resolution limit; λ = wave length) :

   A. $\delta \propto \lambda$

   B. $\delta \propto \lambda^2$

   C. $\delta \propto \lambda^{1/2}$

   D. $\delta \propto \lambda^{-1/2}$

67. The space lattices with two lattice parameters belong to the crystal system:

   A. Tetragonal

   B. Rhombohedral

   C. Hexagonal

   D. All the above

68. The $(1\bar{1}1)$ plane is parallel to

   A. (111)

   B. $(\bar{1}1\bar{1})$

   C. $(\bar{1}\bar{1}1)$

   D. $(11\bar{1})$

69. The majority charge carriers in p-type Ge are

   A. Free electrons
   B. Ions
   C. Holes
   D. Conduction electrons

70. In parabolic rate of oxidation, the oxide thickness is proportional to
   A. $t^{1/2}$
   B. t
   C. t^2
   D. None of these

71. If the surface crack causing fracture in a brittle material is made twice as deep, the fracture strength will
   A. Decrease by a factor of $\sqrt{2}$
   B. Decrease by a factor of 2
   C. Decrease by a factor of 4
   D. No change

72. The transition from ferromagnetic to paramagnetic state is named after

    A. Bohr
    B. Curie-Weiss
    C. Neel
    D. Debye

73. The heat affected zone of a welded steel component will have

    A. Higher grain size

    B. Segregation at the grain boundaries

    C. Both A and B

    D. Grain structure similar to base material

74. Which of the following materials does not have covalent bonds

    A. Cu
    B. Si
    C. Organic Polymers
    D. Diamond

75. The specific heat of insulating crystals, at low temperatures, varies as,

    A. AT^3
    B. $BT+CT^3$
    C. $D \exp(E/T)$
    D. Remains unchanged with temperature

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