

ENTRANCE EXAMINATIONS, February 2013

QUESTION PAPER

M.Tech.(Materials Engineering) and Ph.D.(Materials Engineering)

Marks: 75

Time: 2.00 hrs

Hall Ticket no:

- I. Write your ~~name~~ 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:



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 20 pages including this cover sheet.

PART 'A'

1. For first order differential equation, $\frac{dy}{dx} + ky = 0$ where k is a constant and $y(x=0) = 1$, the solution is
 - A. $y = e^{kx}$
 - B. $y = e^{-kx}$
 - C. $y = e^{k/x}$
 - D. $y = e^{x/k}$

2. An example of intensive thermodynamic property is
 - A. Entropy
 - B. Pressure
 - C. Volume
 - D. Free energy

3. In a homogeneous system with ' c ' components and ' n ' phases under constant temperature and pressure, the total number of independent thermodynamic variables is
 - A. $c - n$
 - B. $c + n$
 - C. $c - n + 2$
 - D. $c - n - 2$

4. Which of the following statements is true?
 - A. Both screw and edge dislocation contain extra plane above or below the slip plane
 - B. Edge dislocation contain extra plane above or below the slip plane
 - C. Screw dislocation contain extra plane above or below the slip plane
 - D. None of the above

5. The dimensional formula for specific heat capacity (all symbols have standard meaning) is
- A. $M^0L^2T^{-2}\theta^{-1}$
 - B. $MLT^2\theta^{-1}$
 - C. $M^0LT^2\theta^{-1}$
 - D. $M^0L^{-2}T^{-2}\theta^{-1}$
6. For a thermodynamic system to be stable under constant temperature and pressure,
- A. Its Gibb's free energy should be maximum
 - B. Its Gibb's free energy should be minimum
 - C. Its enthalpy should be minimum
 - D. Its entropy should be minimum
7. The number of close packed planes in face centred cubic structure are
- A. 2
 - B. 4
 - C. 6
 - D. 8
8. The limit of resolution of an optical microscope is equal to
- A. The wavelength of the radiation
 - B. Magnifying power of the eyepiece
 - C. Aperture size
 - D. Polarization of the radiation
9. Which one of the following elements can have positive oxidation state?
- A. Cs
 - B. Br
 - C. O
 - D. None of the above

10. The work function of Na is 2.3eV. What is the maximum wavelength of light that will cause photoelectrons to be emitted from Na?
- A. 488 nm
 - B. 540 nm
 - C. 668 nm
 - D. 780 nm
11. Paramagnetic alpha iron changes to gamma iron at
- A. 770°C
 - B. 1440°C
 - C. 910°C
 - D. 1539°C
12. For an ideal gas $C_p - C_v$ is
- A. R
 - B. -R
 - C. 0
 - D. ∞
13. Units of Diffusion Coefficient are:
- A. No units
 - B. m^2/sec
 - C. N/m^2
 - D. N/sec^2
14. Which variety of Cu has the best electrical conductivity?
- A. Pure annealed Cu
 - B. Cu containing moderate concentration of oxygen
 - C. Cold worked Cu
 - D. None of the above

15. Nickel which is to the left of Cu ($3d^{10}4s^1$) in the first transition metal series has an outer electronic configuration of
- A. $3d^94s^1$
 - B. $3d^84s^2$
 - C. $3d^{11}4s^1$
 - D. $3d^{10}4s^2$
16. Atomic packing factor for the diamond cubic structure is
- A. 0.74
 - B. 0.68
 - C. 0.34
 - D. 0.25
17. The value of the summation $\sum_{n=1}^{\infty} \frac{x^n}{n!}$ is
- A. $\ln(x)$
 - B. $\ln(x) + 1$
 - C. e^x
 - D. $e^x - 1$
18. The following thermocouple may be used to measure temperature up to 1773 K
- A. Chromel - alumel
 - B. Copper - constantan
 - C. Iron - constantan
 - D. Platinum - Platinum rhodium
19. The alloy used for cladding in thermal power reactors containing natural uranium as fuel is
- A. Stainless steel
 - B. Zirconium alloy
 - C. Cadmium alloy
 - D. Aluminium alloy

20. The melting temperature of an intermetallic compound is
- A. Spread over a range
 - B. A single temperature
 - C. Indeterminate
 - D. Always greater than the melting point of the major constituent
21. Which one is the natural polymer ?
- A. Cellulose
 - B. Polyethylene
 - C. Polyester
 - D. Vulcanized rubber
22. Ester is formed when alcohol reacts with
- A. Carboxylic acid
 - B. Aldehyde
 - C. Ketone
 - D. Ether
23. The domain wall motion in ferromagnetic Fe is obstructed by
- A. Dislocation tangles
 - B. Impurity atoms
 - C. Non-magnetic inclusions
 - D. All of the above
24. For lasing action the energy gap of a semiconductor should be
- A. Direct bandgap
 - B. Indirect gap
 - C. No band gap
 - D. None of the above

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25. c/a ratio of ideal HCP unit cell is

- A. 1
- B. 1.54
- C. 1.63
- D. 1.88

PART 'B'

26. Cast iron is used in the base of machinery subjected to intermittent loading because of its

- A. Load shedding capacity
- B. Damping capacity
- C. Anti-friction property
- D. High thermal conductivity

27. $\lim_{x \rightarrow 0} \frac{x \sin \frac{x}{2}}{1 - \cos x}$ is

- A. 1
- B. 2
- C. 0
- D. $\frac{1}{2}$

28. If a wire of length L is embedded along the axis in a cylinder of height H ($H > L$), the probability of observing the wire when a random section is cut perpendicular to axis of cylinder is

- A. L/H
- B. H/L
- C. $2L/H$
- D. none of these

29. Which of the following statements is true?

- A. Engineering stress and true stress have the same value
- B. Engineering strain and true strain have the same value
- C. Engineering stress is higher than the true stress
- D. Engineering stress is lower than the true stress

30. Indirect extrusion is also known as
- Forward extrusion,
 - Backward extrusion
 - Extrusion
 - Shape extrusion
31. The volume occupied by the parallelepiped formed by the vectors $\bar{a} = \frac{1}{2} \hat{i} + \frac{\sqrt{3}}{2} \hat{j}$, $\bar{b} = -\frac{1}{2} \hat{i} + \frac{\sqrt{3}}{2} \hat{j}$ and $\bar{c} = \frac{4}{\sqrt{3}} \hat{k}$ is
- 2
 - $4/\sqrt{3}$
 - 1
 - $2/\sqrt{3}$
32. Zone refining is
- An equilibrium process
 - Non-equilibrium process
 - Grain refining process
 - Deformation process
33. In energy dispersive spectrometer attached to an electron microscope, the elemental identification is carried out using
- Characteristic x-rays
 - Bremsstrahlung
 - Auger electrons
 - Photoelectrons
34. Stacking sequence along [110] direction of face centred cubic structure is
- ABABABABAB....
 - ABCABCABC.....
 - ABACABACAB.....
 - AABBAABBAABB...

35. Driving force for grain growth after complete recrystallisation is
- A. Stored energy of cold work
 - B. Reduction in grain boundary area
 - C. Reduction in dislocation density
 - D. None of the above
36. The number of second nearest neighbours in simple cubic structure is
- A. 8
 - B. 6
 - C. 12
 - D. 10
37. Torsion test can be used to determine
- A. Young's modulus of material
 - B. Shear modulus of material
 - C. Bulk modulus of material
 - D. Elastic limit of material
38. Pig iron is produced in
- A. Bessemer converter
 - B. Open hearth furnace
 - C. Blast furnace
 - D. Cupola
39. Forging is a
- A. Batch process
 - B. Continuous process
 - C. A semi-continuous process
 - D. Sheet working process

40. If $C = AB - BA$, where $A = \frac{1}{2} \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ and $B = \frac{1}{2} \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$, then the eigen values of C are
- A. $\frac{i}{2}$ and $-\frac{i}{2}$
 - B. $\frac{1}{2}$ and $-\frac{1}{2}$
 - C. $\frac{i}{4}$ and $-\frac{i}{4}$
 - D. $\frac{1}{4}$ and $-\frac{1}{4}$
41. A radioactive nucleus of type 1 decays exponentially with a decay constant λ_1 to stable nucleus of type 2 if at time $t = 0$, the number of type 1 and 2 nuclei are respectively $N_1(t = 0) = N_0$ and $N_2(t = 0) = 0$, what is the number of type 2 nucleus present at time t ?
- A. $N_0 \exp - \lambda_1 t$
 - B. $N_0 (1 - \exp - \lambda_1 t)$
 - C. $N_0 (1 + \exp - \lambda_1 t)$
 - D. $1 - N_0 \exp - \lambda_1 t$
42. Above Curie temperature, the hysteresis loop of a ferro-electric material merges into a
- A. Point
 - B. Straight line
 - C. Parabola
 - D. Cycloid
43. Above the Neel temperature, a magnetic material becomes
- A. Ferromagnetic
 - B. Paramagnetic
 - C. Diamagnetic
 - D. None of the above

44. In superconducting state
- A. Entropy and thermal conductivity decrease
 - B. Entropy and thermal conductivity increase
 - C. Entropy decreases while thermal conductivity increases
 - D. Entropy increases while thermal conductivity decreases
45. The Miller indices are same for
- A. a plane and directions in those planes
 - B. Parallel planes
 - C. Planes perpendicular to each other
 - D. Planes having the same interplanar spacing
46. A certain amount of ice at 0°C melts into water at 0°C and in so doing gains 1kg of mass. Calculate its initial mass.
- A. 2.7×10^{11} g
 - B. 2.7×10^{11} kg
 - C. 3.8×10^{11} g
 - D. 3.8×10^{11} kg
47. Erosion – corrosion is a
- A. Chemical attack
 - B. Mechanical abrasion
 - C. Combined action of chemical attack and mechanical abrasion
 - D. Due to fluid velocity
48. Laplace transform $F(s) = \int_0^{\infty} dt e^{-st} f(t)$ of the function $f(t) = \frac{1}{\sqrt{\pi t}}$ is
- A. $\frac{1}{\sqrt{s}}$
 - B. \sqrt{s}
 - C. $\frac{1}{\sqrt{\pi s^{3/2}}}$
 - D. $\frac{1}{\sqrt{\pi s}}$

49. Which of the following is the hardest material?
- A. Hardened steel
 - B. Tungsten carbide
 - C. Boron carbide
 - D. Alloy steels
50. Permalloy is a
- A. Kind of stainless steel
 - B. Polymer
 - C. Nickel and iron alloy having high permeability
 - D. Cutting tool material
51. Which of the following is not a casting process?
- A. Chills process
 - B. Extrusion
 - C. Semi-centrifuge method
 - D. Slush process
52. Which is the false statement about tempering?
- A. Improves toughness
 - B. Improves machinability
 - C. Releases stresses
 - D. Reduces hardness and brittleness
53. The minimum energy required to impose an elastic strain of ϵ to a metal having unit volume and a constant flow stress, σ , is
- A. $\sigma \epsilon$
 - B. $2 \sigma \epsilon$
 - C. $\frac{1}{2} \sigma \epsilon$
 - D. $\frac{3}{4} \sigma \epsilon$

54. The elastic strain in copper is due to
- A. Change in atomic bond length
 - B. Breakage of atomic bonds
 - C. Motion of dislocation
 - D. None of the above
55. During tensile test, a ductile fracture is characterized by
- A. Beach marks
 - B. Cup and Cone
 - C. Cleavage facets
 - D. Quasi-cleavage
56. Dislocation generation in polycrystalline materials occurs by
- A. Cottrell-Bilby source
 - B. Johnston-Gilman source
 - C. Frank-Read source
 - D. Nabarro-Herring source
57. A small amount of thoria is doped into tungsten filament wires used in light bulbs. This is because thoria particles
- A. Decreases solute diffusivity
 - B. Enhances the mobility of grain boundary
 - C. Increases solute segregation to grain boundary
 - D. Are effective in limiting grain growth
58. Shear modulus of Al is 28.0 GPa. The theoretical fracture strength of dislocation free single crystal of aluminium is
- A. 28.0 GPa
 - B. 9.3 GPa
 - C. 0.1 GPa
 - D. 0.01 GPa

59. A crystal undergoes a transformation from FCC to BCC structure but the lattice parameter remains the same for both phases. Which of the following statements is true?
- A. Density of materials before and after the transformation and the volume of the unit cell are different
 - B. Density of materials before and after the transformation is the same but volume of the unit cell is different
 - C. Density of materials before and after the transformation is the same but volume of the unit cell before and after the transformation is the same
 - D. Density of materials before and after the transformation is different but volume of the unit cell remains the same
60. The spectrum of radiation emitted by black body at a temperature of 1000 K peaks in the
- A. Visible range of wavelengths
 - B. Infra red range of wavelengths
 - C. Ultra violet range of wavelengths
 - D. Radio wave range of wavelengths
61. If the volume of unit cube of a material does not change during deformation, then the Poisson's ratio should be
- A. 0.25
 - B. 0.37
 - C. 0.50
 - D. 1.0
62. The defects which have most detrimental effect on the fracture toughness of materials are
- A. Fine coherent precipitates
 - B. Inclusion
 - C. Incoherent spherical precipitates
 - D. Microcracks

63. The empirical relationship that exhibits linear relationship between cyclic stress and mean stress on fatigue life is called as
- A. Gerber's relationship
 - B. Goodman relationship
 - C. Baushinger relationship
 - D. Coffin-Manson relationship
64. During the ferromagnetic to paramagnetic transition of iron, the property that changes abruptly is
- A. Gibb's free energy
 - B. Enthalpy
 - C. Entropy
 - D. Heat capacity
65. During stretching of an ideal elastomer, its enthalpy
- A. Increases
 - B. Remains constant
 - C. Decreases
 - D. None of the above
66. Eutectoid reaction is given by
- A. $\text{Liquid1} \leftrightarrow \text{Solid1} + \text{Liquid2}$
 - B. $\text{Liquid1} + \text{Liquid2} \leftrightarrow \text{Liquid3}$
 - C. $\text{Liquid1} \leftrightarrow \text{Solid1} + \text{Solid2}$
 - D. $\text{Solid1} \leftrightarrow \text{Solid2} + \text{Solid3}$
67. Radiation pyrometers are used
- A. For measurement of radiation dose
 - B. For determining viscosity of liquids
 - C. For temperature measurement
 - D. For measuring length of rail track

68. The yield-point phenomenon observed in annealed low carbon steel is due to the presence of
- A. Silicon
 - B. Carbon
 - C. Phosphorous
 - D. Chromium
69. A cold worked material is annealed at high temperature. Increase in the percentage of cold work, the recrystallization temperature
- A. Increases
 - B. Decreases
 - C. Remains constant
 - D. None of the above
70. Why are semiconductors transparent to IR light although opaque to visible light?
- A. Valence electrons can find unoccupied excited energy states in the conduction band for any excitation energy, however small
 - B. The energy gap is so large that photons of visible light cannot provide enough excitation energy from electrons in the valence band to reach the conduction band
 - C. The energy gap is small and so photons of visible light can excite valence electrons to the conduction band although photons of IR light have insufficient energy for the purpose
 - D. None of the above
71. Routine inspection for defects in locomotive axles and rails can be possible by
- A. Radiography
 - B. Ultrasonic testing
 - C. Thermography
 - D. Holography

72. On increasing the impurity concentration in the metal, the residual component of the resistivity
- A. Decreases
 - B. Increases
 - C. Remains constant
 - D. Can be made zero
73. The processing method used to improve the creep resistance of the material by reduction of transverse grain boundaries is
- A. Rotary swaging
 - B. Directional solidification
 - C. Cold rolling
 - D. Hot extrusion
74. Martensitic transformation is a
- A. Diffusional transformation
 - B. Displacive transformation
 - C. Spinodal transformation
 - D. Ordering transformation
75. The ASTM grain size number N for a structural steel which shows 65 grains per square inch at a magnification of $100X$ is
- A. 1
 - B. 3
 - C. 5
 - D. 7