

ENTRANCE EXAMINATIONS, JUNE 2011 QUESTION PAPER

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

Marks: 75

Time: 2.00 hrs

Hall Ticket no:

- I. Write your Booklet Code and 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 both the question paper booklet and the OMR answer sheet at the end of the examination.
 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. The Heisenberg uncertainty principle says that the product $\Delta x \Delta p_x$ is

- A. 0
- B. $\geq h/4\pi$
- C. $\leq h/4\pi$
- D. = h where h is the Planck's constant

2. The Joule-Thompson coefficient for an ideal gas is

- A. Zero
- B. Positive
- C. Negative
- D. Either positive or negative

3. Nodular Cast Iron is produced

- A. From White Cast Iron by heat treatment
- B. By inoculation of cast iron melt
- C. By hot working Grey Cast Iron
- D. By cold working of nodular cast iron

4. Progressive accumulation of damage of a material under cyclic loading conditions is called as

- A. Fatigue
- B. Ductility
- C. Creep
- D. Malleability

5. Hexagonal Closed Packed materials will have the following stacking sequence:

- A. ABABABABAB.....
- B. ABCABCABCABC.....
- C. ABCABCACBCAB.....
- D. ABABBAABAABBA.....

6. Zone Refining is:

- A. A process of purifying metals
- B. Estimating grain orientation
- C. Estimating velocity of a rocket
- D. Evaluating the exact composition of a substance

7. The steel making process that uses oxygen lancing of melt is

- A. LD
- B. Open Hearth
- C. Bessemer convertor
- D. Cupola

8. The phenomenon of a metal existing more than in one crystalline form is known as

- A. Amorphous
- B. Allotropy
- C. Isomorphism
- D. Condensation

9. Under equilibrium cooling conditions, the solidification of pure iron from the liquid occurs at

- A. 1130 °C
- B. 910 °C
- C. 1492 °C
- D. 1540 °C

10. The combination of planes and directions on which slip takes place in metallic materials is known as

- A. Slip system
- B. Kinks
- C. Dislocation channeling
- D. Jogs

11. The number of electrons present in the outer shell of the noble gases Neon and Argon

- A. 3
- B. 5
- C. 7
- D. 8

12. If the coordination numbers of two unit cells are same, they both will have similar

- A. Atomic weight
- B. Ductility
- C. Packing factor
- D. Crystal structure

13. The point defects strengthen metals and decrease their ductility by

- A. Promoting covalent bonding
- B. Promoting ionic bonding
- C. Impeding the motion of dislocations
- D. Increasing the density of metal

14. Bohr radius of the first electron orbit of a Hydrogen atom is

- A. 5.3×10^{-5} cm
- B. 5.3×10^{-7} cm
- C. 5.3×10^{-9} cm
- D. 5.3×10^{-11} cm

15. Solar cells are basically

- A. Photoconductive
- B. Photoemissive
- C. Photovoltaic
- D. Photoresistive

16. Soft iron is used in many parts of electrical machines for

- A. Low hysteresis loss and low permeability
- B. Low hysteresis loss and high permeability
- C. High hysteresis loss and low permeability
- D. High hysteresis loss and high permeability

17. A very large Reynolds' number is an indication of

- A. High turbulent flow
- B. Laminar flow
- C. Smooth and streamline flow
- D. None of the above

18. A free radical can be best detected by

- A. Nuclear Magnetic Resonance
- B. Nuclear Quadrupole Resonance
- C. Electron Spin Resonance
- D. Infrared Spectroscopy

19. Quenching of plain carbon steel is a process that

- A. Softens the material
- B. Produces Pearlite
- C. Hardens the material
- D. Spheroidizes the carbides

20. 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. $1 - N_0 \exp - \lambda_1 t$

21. If $[x]$ stands for largest integer not exceeding x , the integral

$$\int_{-1}^{+2} [x] dx \quad \text{equals,}$$

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

22. The matrix $\begin{pmatrix} 5 & -1 \\ 1 & 3 \end{pmatrix}$ has

- A. No independent eigenvectors
- B. 1 independent eigenvector
- C. 2 independent eigenvectors
- D. 3 independent eigenvectors

23. Resolution of a scanning electron microscope is determined by the

- A. Wavelength of the electron beam
- B. Objective lens
- C. Condenser lens
- D. Beam size

24. The Miller indices of the diagonal plane of a cube are

- A. (110)
- B. (010)
- C. (001)
- D. (111)

25. The relationship between Young's modulus (E), Modulus of rigidity (η) and Poisson's ratio (ν) is

- A. $E=2\eta (1+\nu)$
- B. $\eta=2E (1+\nu)$ -
- C. $\nu=2E/ (1+\eta)$
- D. $E= \eta (1+\nu)$

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PART 'B'

26. "Thermodynamic death" is suggested by

- A. The first law of thermodynamics,
- B. The second law of thermodynamics
- C. The third law of thermodynamics
- D. Zeroeth law of thermodynamics

27. β -brass, CuZn (BCC) is

- A. An electron compound
- B. A size factor compound
- C. An electrochemical compound
- D. An intermetallic compound

28. The Czochralski apparatus can be used to produce

- A. Polycrystals of silicon
- B. Single crystal ingots
- C. High temperature ceramics
- D. Steels for cryogenic applications

29. The prime function of a cutting fluid is

- A. To decrease friction, wear and heat generation in the cutting region
- B. To quench the tool during cutting to make it hard by phase transformation
- C. To impart colour to the surface of the part being machined
- D. To corrode the newly machined surface

30. The improvement in high cycle fatigue resistance of steel is obtained by having

- A. Fine grain size
- B. Surface decarburization
- C. Tensile residual stresses on surface
- D. Presence of globular inclusions of oxides

31. $\text{YBa}_2\text{Cu}_3\text{O}_7$ is a

- A. Superconductor
- B. Semiconductor
- C. Soft magnet
- D. Dielectric material

32. The season cracking of Brass in ammonia bearing environment is the following type of corrosion

- A. Stress corrosion
- B. Galvanic corrosion
- C. Pitting corrosion
- D. Inter-granular corrosion

33. Martensite transformation is an example of

- A. Reconstructive transformation
- B. Displacive transformation
- C. Diffusion phase transformation
- D. Massive phase transformation

34. Creep failure at very high temperatures ($> 0.6T_M$, where T_M is absolute temperature in Kelvin) is identified by the presence of

- A. Cavities on grain boundaries
- B. Dimples on fracture surface
- C. Pits on fracture surface
- D. Striations

35. The unit for plane-strain fracture toughness

- A. MN/m
- B. MN/m^2
- C. $\text{MN/m}^{3/2}$
- D. $\text{MN/m}^{1/2}$

36. A defect that is bounded by two mirror planes is

- A. Stacking fault
- B. Twin
- C. Grain boundary
- D. Screw dislocation

37. Poisson's ratio refers to

- A. Strength in transverse direction/strength in the longitudinal direction
- B. Minimum stress/maximum stress in a fatigue cycle
- C. Strain in transverse direction/strain in the longitudinal direction
- D. Strain in the longitudinal direction/strain in transverse direction

38. Grey cast iron is preferred for machine beds due to

- A. High fatigue strength
- B. High damping capacity
- C. Very high ductility
- D. Its light weight

39. Tendency for grain growth in steels can be strongly reduced by the addition of

- A. Al, Ti and V
- B. S, P and Sb
- C. Mn, Ni and C
- D. Ba, Cu and Mn

40. The dynamic hardness of a metal surface is obtained using

- A. Shore scleroscope
- B. Rockwell C hardness test
- C. Moh's hardness test
- D. Brinell hardness test

41. The integral $\int_0^1 xe^x dx$ is equal to

- A. 0
- B. 0.5
- C. 1
- D. 3.5

42. "Meissner effect" is associated with

- A. Superplasticity,
- B. Superelasticity,
- C. Superconductivity
- D. Superalloys

43. Directional Solidification can be used to produce

- A. Creep-resistant materials required for aerospace applications
- B. Shape memory alloys
- C. Fuel clad tubes for nuclear reactors
- D. Materials for Railway axles

44. Ultimate tensile strength is given by:

- A. Maximum load/original area of cross section
- B. Maximum load/instantaneous area of cross section
- C. Yield load/original area of cross section
- D. Yield load/instantaneous area of cross section

45. Elements A and B will form a solid solution under the following condition (a_A , a_B are lattice parameters of A and B respectively)

- A. $|a_A - a_B| > 15\%$
- B. $|a_A - a_B| < 15\%$
- C. $|a_A + a_B| < 15\%$
- D. $|a_A + a_B| > 15\%$

46. Ellingham diagram is a representative plot between:

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

47. A thermocouple is used to measure temperature. It works on the principle expounded by

- A. Seebeck
- B. Einstein
- C. Raman
- D. Roentgen

48. Fermi level of a metal defines

- A. The highest occupied level of electron energies at absolute zero
- B. The lowest occupied level of electron energies at absolute zero
- C. The highest occupied level of electron energies at room temperature
- D. The band gap in an intrinsic semi-conductor

49. An intermetallic that is superconducting is

- A. Ni_3Al
- B. Nb_3Sn
- C. Ti_3Al
- D. MoSi_2

50. Peak strengthening in age hardening Al-Cu alloys is derived from

- A. Local clustering of copper atoms
- B. Ordering of copper atoms on {100} planes of matrix
- C. Formation of coherent precipitate platelets of CuAl_2
- D. The occurrence of an equilibrium phase CuAl_2

51. The alloying element that facilitates the formation of passive layer in stainless steels

- A. Nickel
- B. Carbon
- C. Niobium
- D. Chromium

52. Major strengthening phase in Ni-base superalloys is

- A. Gamma-prime
- B. Sigma Phase
- C. Chromium carbide
- D. Eta-phase

53. Radiation pyrometers are used

- A. For measurement of radiation dose
- B. For determining viscosity of the liquids
- C. For temperature measurement
- D. For measuring length of rail track

54. To calculate the residual stresses in a material using X-ray diffraction, the following parameter is used

- A. Area under the peak
- B. Maximum intensity of the peak
- C. Full width at half maximum of the peak
- D. Full width at full maximum of the peak

55. Pig iron is produced in

- A. Bessemer converter
- B. Open hearth furnace
- C. Blast furnace
- D. Cupola

56. Differential Scanning Calorimetry is used for the determination of

- A. Surface topography
- B. Co-efficient of thermal expansion
- C. Phase transformations
- D. Grain boundary chemical analysis

57. A material, which develops a voltage when subjected to mechanical compression, twisting or distortion is known as

- A. Piezoelectric
- B. Pyroelectric
- C. Magnetostrictive
- D. Ferroelectric

58. Joule-Thompson expansion of an ideal gas is

- A. Adiabatic
- B. Isobaric
- C. Isothermal
- D. Isocoric

59. The limit of resolution of a microscope is given by

- A. The wavelength of the radiation
- B. Magnifying power of the eyepiece
- C. Aperture size
- D. Polarization of the radiation

60. The units of magnetic flux density are

- A. Ampere
- B. Weber
- C. Tesla
- D. Faraday

61. During machining of cast iron at low cutting speeds, the type of chip that gets generated is

- A. A discontinuous chip
- B. A continuous chip
- C. A continuous chip with build-up-edge
- D. Shear localized chip

62. The resistance to relative motion between two bodies in contact under a normal load is defined as

- A. Erosion
- B. Wear
- C. Friction
- D. Fretting

63. Hot tops in the moulds are provided to reduce the

- A. depth of the shrinkage cavity formed in ingot
- B. usage of molten metal in ingot
- C. size of the ingot
- D. oxidation of molten metal

64. Toughness of a material is given by

- A. Its total mass
- B. Its surface area
- C. Area under the stress-strain curve
- D. The slope of the stress-strain curve below proportional limit

65. Which of the following expresses Boyle's law correctly

- A. $\frac{dV}{dP} = 1$
- B. $\frac{dV}{dP} = \frac{P}{V}$
- C. $\frac{dV}{dP} = \frac{V}{P}$
- D. $\frac{dV}{dP} = -\frac{V}{P}$

66. The binary representation of the decimal number 7.125 is

- A. 111.111
- B. 111.010
- C. 111.001
- D. 111.100

67. The electrodes used for resistance welding

- A. Copper-Chromium alloys
- B. Flux coated mild steel electrodes
- C. Tungsten filler wire
- D. Rotating anode

68. The yield strength of many metals and alloys has been found

- A. To vary linearly with grain size
- B. To vary as square root of grain size
- C. To vary as inverse of square root of grain size
- D. To vary as square of grain size

69. Hume-Rothery proposed that the formation of electron compounds occur at the following ratios

- A. 21/12, 21/13, 21/14
- B. 3/2, 3/4, 3/5
- C. 7/4, 7/5, 7/6
- D. 1/3, 2/3, 4/3

70. The processing method to improve the creep resistance of the material by reduction of transverse grain boundaries

- A. Rotary swaging
- B. Directional solidification
- C. Cold rolling
- D. Hot extrusion

71. The following element is a fertile isotope in nuclear fuels

- A. U^{235}
- B. Pu^{239}
- C. Th^{232}
- D. U^{233}

72. The dimensional formula for specific heat capacity is

- A. $M^0L^2T^{-2}\theta^{-1}$
- B. $MLT^2\theta^{-1}$
- C. $M^0LT^2\theta^{-1}$
- D. $M^0L^{-2}T^{-2}\theta^{-1}$

73. The First law of Thermodynamics is represented by

- A. $dQ=TdS$
- B. $dQ=dU+dW$
- C. $PV=\text{constant}$
- D. $PV=nRT$

74. For a thermodynamic system to be stable,

- A. Its free energy should be maximum
- B. Its free energy should be minimum
- C. Its enthalpy should be minimum
- D. Its entropy should be minimum

75. One of the following is an Eutectic reaction,

- A. $\text{Liquid1} \rightarrow \text{Solid1} + \text{Solid2}$
- B. $\text{Liquid1} \rightarrow \text{Liquid2} + \text{Solid1}$
- C. $\text{Liquid1} + \text{Solid1} \rightarrow \text{Solid2}$
- D. $\text{Solid1} \rightarrow \text{Solid1} + \text{Solid2}$