

# 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      ☒ D

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 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.  $5.3 \times 10^{-5}$  cm
- B.  $5.3 \times 10^{-7}$  cm
- C.  $5.3 \times 10^{-9}$  cm
- D.  $5.3 \times 10^{-11}$  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 Quadrapole 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. Spherodizes the carbides

20. A radioactive nucleus of type 1 decays exponentially with a decay constant  $\lambda_1$  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 ( $\eta$ ) and Poisson's ratio ( $\nu$ ) is

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

**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.  $\beta$ -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.  $\text{MN/m}$
- B.  $\text{MN/m}^2$
- 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.  $\Delta G$  vs  $T$
- B.  $\Delta G$  vs  $P$
- C.  $\Delta U$  vs  $T$
- D.  $\Delta U$  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.  $\text{Ni}_3\text{Al}$
- B.  $\text{Nb}_3\text{Sn}$
- C.  $\text{Ti}_3\text{Al}$
- D.  $\text{MoSi}_2$

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  $\text{CuAl}_2$
- D. The occurrence of an equilibrium phase  $\text{CuAl}_2$

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.  $\text{U}^{235}$
- B.  $\text{Pu}^{239}$
- C.  $\text{Th}^{232}$
- D.  $\text{U}^{233}$

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.  $\text{Solid1} \rightarrow \text{Solid1} + \text{Solid2}$