U-90

ENTRANCE EXAMINATIONS, JUNE 2010
QUESTION PAPER

M.Tech./Ph.D.(Nano Science and Technology)

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:

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

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

2. C_{60} has

   A. 12 pentagons and 18 hexagons
   B. 12 pentagons and 20 hexagons
   C. 10 pentagons and 20 hexagons
   D. 14 pentagons and 18 hexagons

3. $\int \frac{dx}{a+bx}$ is

   A. $\frac{1}{b}\ln(a+bx)+c$
   B. $\ln(a+bx)+c$
   C. $b\ln(a+bx)+c$
   D. $\frac{1}{a}\ln(a+bx)+c$

4. Energy gap of silicon at room temperature is

   A. 0.7 eV
   B. 1.1 eV
   C. 5.0 eV
   D. 1.5 eV

5. "Meisner effect" is associated with

   A. superplasticity,
   B. superelasicity,
   C. superconductivity
   D. superalloys

6. "Buckey balls" are made of

A. C_{60} molecules
B. a metallic glass
C. a polymeric material
D. superconductors

7. Skin allergy results from the interaction of sweat and other body fluids with

A. nickel ions
B. nitrogen ions
C. titanium ions
D. none of these

8. Tetragonal phase ZrO_2 can be stabilized down to room temperature by adding a small amount of

A. Y_2O_3
B. Be
C. La
D. Sn

9. Polygonization is the phenomenon where

A. dislocations disappear into grain boundaries,
B. dislocations are generated by the operation of Frank-Read sources
C. mobile dislocations present in the material are rearranged in cell walls
D. dislocations form tangles

10. 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

11. The lowest density in a powder metallurgy product is its

A. green density
B. theoretical density
C. sintered density
D. smear density

12. Grain boundary sliding is promoted by

A. elevated temperatures and decreasing strain rate
B. elevated temperatures and increasing strain rate
C. sub zero temperatures and decreasing strain rate
D. smbient temperature and increasing strain rate

13. 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

14. 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. $|a_A+a_B| > 15\ \%$

15. Dislocations in metals are characterized by

A. etch-pitting
B. transmission Electron Microscopy
C. both A and B
D. none of these

16. Hall-Petch slope "k" in the equation, $\sigma_y=\sigma_i+kd^{-1/2}$ will have the units of

A. no units because it is a constant
B. N/m^2
C. $N/m^{1/2}$
D. $N/m^{3/2}$

17. The following are equilibrium defects

A. dislocations
B. vacancies
C. stacking faults
D. cracks

18. Dislocation multiplication in polycrystalline materials occurs by the operation of

A. Cottrell-Bilby source
B. Johnston-Gilman source
C. Frank-Read source
D. Nabarro-Herring source

19. Eutectoid reaction is given by:

A. Liquid1↔Solid+Liquid2
B. Liquid1↔Liquid2+Liquid3
C. Liquid1↔Solid1+Solid2
D. Solid1↔Solid2+Solid3

20. Ellingham diagram is a representative plot between:

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

21. One of the following is correct at room temperature (D is Diffusion Coefficient):

A. D (grain boundaries) < D (lattice)
B. D (grain boundaries) > D (lattice)
C. D (grain boundaries) = D (lattice)
D. D (grain boundaries) / D (lattice) = ∞

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

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

23. The number of free electrons in a completely filled energy band is

A. zero
B. one
C. infinite
D. equal to the number of valance electrons

24. 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

25. A color center is

A. an atom in a crystal that emits radiation in the visible region
B. a lattice vacancy in a crystal
C. a lattice defect in a crystal that absorbs visible light
D. a type of Frenkel defect

PART 'B'

26. To achieve excellent surface finish one resorts to

A. sand casting
B. sand blasting
C. investment casting
D. slip casting

27. An intermetallic that is superconducting is

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

28. Fuel cells are based on a principle which is the converse of

A. oxidation,
B. electrolysis
C. photosynthesis
D. None of these

29. 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 $CuAl_2$

30. Near net-shape components are manufactured by

A. hot isostatic pressing
B. hot pressing
C. activated sintering
D. hydrostatic extrusion

31. The specific heat capacity (C_V) of an insulator at a constant volume V and temperature T is given as

A. $C_V = AT^3$
B. $C_V = AT^2$
C. $C_V = AT^3+BT$
D. $C_V = AT^2+BT$

32. *n*-type semi-conductor is obtained by doping Si with

A. B
B. Al
C. Ga
D. Sb

33. The following alloys are used for soldering

A. Cu-Al
B. Al-Si
C. Cu-Zn
D. Sn-Ag

34. The following is correct in case of nanocrystalline materials with respect to those of conventional grain size

A. the density is high
B. the melting point is high
C. the weight is more
D. the grain boundary specific area is more

35. Diffusion flux has the units of

A. no. of atoms/(area . time)
B. no. of atoms/(volume . time)
C. no. of atoms/(length . time)
D. no. of atoms/(mass . time)

36. The yield point phenomenon observed in annealed plain low carbon steel is due to the presence of

A. carbon
B. manganese
C. silicon
D. phosphorous

37. Wolframite is an important source of

A. titanium
B. tantalum
C. tungsten
D. thorium

38. For a closed system of fixed internal energy and volume, at equilibrium

A. Gibbs free energy is minimum
B. Helmoltz's free energy is minimum
C. enthalaphy is maximum
D. entropy is maximum

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

A. nickel
B. carbon
C. niobium
D. chromium

40. The deeply seated defects in thick components could be detected by

A. eddy current inspection
B. liquid penetrant inspection
C. magnetic particle inspection
D. ultrasonic inspection

41. Kroll's process produces

A. titanium
B. aluminium
C. cadmium
D. plutonium

42. Graphite flakes are important microstructural feature in

A. nodular cast iron
B. white cast iron
C. grey cast iron
D. hypo-eutectoid steel with 0.7% carbon

43. Major strengthening phase in Ni-base superalloys is

A. gamma-prime
B. sigma Phase
C. chromium carbide
D. eta-phase

44. The concept of entropy is introduced by:

A. zeroeth law of thermodynamics
B. first law of thermodynamics
C. second law of thermodynamics
D. third law of thermodynamics

45. Diffusion in materials occurs because of:

A. concentration gradient
B. potential gradient
C. both A and B
D. none of these

46. The following method is not used to estimate grain size in materials

A. ASTM standard chart comparison method
B. Newton-Raphson method
C. Heyn's intercept method
D. Jeffries planimetric method

47. If the grain size of a material is decreased from 40 μm to 40 nm, its oxidation resistance will

A. not change
B. increase
C. decrease
D. none of these

48. The limit of the sequence $\sqrt{2}$; $\sqrt{2\sqrt{2}}$; $\sqrt{2\sqrt{2\sqrt{2}}}$; $\sqrt{2\sqrt{2\sqrt{2\sqrt{2}}}}$ .....

A. 1
B. 2
C. $2\sqrt{2}$
D. ∞

49. In the limit $x \to \infty$, $y = \sqrt{x}\,(\sqrt{x+4} - \sqrt{x})$ is

A. 0
B. 2
C. 1/2
D. does not exist

50. 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

51. Point defects in crystal cannot be produced by

A. elastic deformation
B. plastic deformation
C. quenching from high temperature
D. irradiation with neutrons

52. A certain buffer solution contains equal concentrations of A^- and HA. The K_b for A^- is 10^{-10}. The pH of the buffer is

A. 10
B. 14
C. 7
D. 4

53. Calcium fluoride crystallizes in fluorite structure. The coordination number for the cation and anion is respectively

A. 6, 4
B. 4, 6
C. 8, 4
D. 6, 6

54. A method of removing excess solute from a colloidal solution is by

A. recrystallization
B. gas chromatography
C. distillation
D. dialysis

55. Among the following molecules, the shortest bond length is to be found in

A. C_2
B. F_2
C. N_2
D. O_2

56. The included angle between the opposite faces of diamond pyramid indenter used in the Vicker's hardness test is

A. 0°
B. 90°
C. 136°
D. 180°

57. Sensitization in stainless steels is associated with

A. depletion of Chromium to less than 12% at grain boundaries
B. depletion of Nickel to less than 8% at grain boundaries
C. depletion of Carbon to less than 0.2% at grain boundaries
D. depletion of Titanium to less than 0.5% at grain boundaries

58. Jominy-end quench test is used to measure

A. hardness
B. hardenability
C. toughness
D. stiffness

59. Top-down approach is generally employed

A. for reducing the particle size of powders
B. for increasing the particle size of powders
C. for not altering the particle size of powders
D. none of the above

60. Glass ceramics by definition must contain

A. at least 50% crystalline ceramics by volume
B. 60% glassy material
C. a fully glassy structure
D. a fully ceramic material

61. Materials for orthopedic implants are based on

A. Pb
B. Mg
C. Ti
D. Be

62. The slope of stress-strain curve in the elastic region gives

A. yield strength
B. Youngs' modulus
C. toughenss
D. resilience

63. 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

64. The term diamond-like-carbon is most commonly used to refer to

A. amorphous carbon thin films
B. graphene layers
C. crystalline diamond composites
D. all of the above

65. A powder metallurgy processing route is

A. mechanical alloying
B. melt spinning
C. levitation
D. short peening

66. Pig iron is produced in

A. Bessemer converter
B. open hearth furnace
C. blast furnace
D. Cupola

67. Electron back scattered diffraction is a technique based on

A. optical microscopy
B. scanning electron microscopy
C. atomic force microscopy
D. X-ray diffraction

68. Magnetic flux density is expressed by

A. Ampere
B. Volts
C. Weber
D. Weber/m^2

69. The Reynolds number is the ratio of

A. inertial forces/Viscous forces
B. viscous forces/Inertial forces
C. viscous forces/gravitational forces
D. gravitational forces/Viscous forces

70. The two elements responsible for the production of nuclear power by fusion are

A. deuterium and tritium
B. uranium and plutonium
C. thorium and plutonium
D. tritium and uranium

71. Defects in electronic circuits can be studied by

A. magnetic particle inspection
B. thermography
C. ultrasonic testing
D. holography

72. 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

73. Bronze is an alloy of copper and

A. gold
B. silver
C. tin
D. zinc

74. The following has the highest Co-efficient of Thermal Expansion

A. plastics
B. ceramics
C. tin
D. tungsten

75. The type of corrosion that produces localized attack is

A. pitting corrosion
B. uniform corrosion
C. intergranular corrosion
D. stress corrosion cracking