

# ENTRANCE EXAMINATIONS, JUNE 2012

## QUESTION PAPER


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

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 19 pages including this cover sheet.

A-95

**PART 'A'**

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

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

2. The process used to introduce compressive residual stresses in near-surface regions for improving fatigue resistance

- A. Electroslag remelting
- B. Sand casting
- C. Mechanical alloying
- D. Laser shock peening

3. The fabrication step of mechanical grinding in nano science and technology is considered as an approach of

- A. Bottom up
- B. Top down
- C. Middle up
- D. Middle down

4. Equi channel angular pressing is

- A. A Severe plastic deformation technique for producing ultrafine grained structures
- B. A metal forming process for shaping flat sheets into cup shaped articles
- C. A metal forming process to produce square shaped grooves
- D. A method to produce coarse grain materials

5. Buckminster fullerene, a spherical molecule with the formula of  $C_{60}$  comprises of
- A. 12 pentagons and 20 hexagons
  - B. 10 pentagons and 20 hexagons
  - C. 12 pentagons and 18 hexagons
  - D. 14 pentagons and 18 hexagons
6. Mechanical alloying is a process in which grain refinement occurs
- A. By mixing of metals in a liquid state
  - B. By alloying molten liquid by Aluminum
  - C. Due to co-precipitation in a chemical process
  - D. By repeated deformation, fracturing and cold welding of powder particles in a ball mill
7. Giant Magneto Resistance is
- A. Resistance of a thin film structure to mechanical deformation
  - B. Resistance of a thin film structure to chemical degradation
  - C. A quantum mechanical phenomenon occurring in a multilayered thin film structure
  - D. A classical mechanical phenomenon occurring in a multilayered thin film structure
8. A sintering technique using pulsed DC current that directly passes through graphite dye and powder to be consolidated in case of conductive samples
- A. Spark plasma sintering
  - B. Activated sintering
  - C. Liquid phase sintering
  - D. Microwave sintering
9. Polygonization is the phenomenon where
- A. Dislocations disappear into grain boundaries,
  - B. Mobile dislocations present in the material are rearranged in cell walls
  - C. Dislocations are generated by the operation of Frank-Read sources
  - D. Dislocations form tangles

10. Ultimate tensile strength is given by
- A. Yield load/original area of cross section
  - B. Yield load/instantaneous area of cross section
  - C. Maximum load/instantaneous area of cross section
  - D. Maximum load/original area of cross section
11. An example of line defects in crystals
- A. Dislocations
  - B. Vacancies
  - C. Stacking faults
  - D. Interstitials
12. Fermi level of a metal defines
- A. The lowest occupied level of electron energies at absolute zero
  - B. The highest occupied level of electron energies at room temperature
  - C. The highest occupied level of electron energies at absolute zero
  - D. The band gap in an intrinsic semi-conductor
13. In Hall-Petch equation,  $\sigma_y = \sigma_i + kd^{-1/2}$ , the relative hardening contribution of the grain boundaries is described by
- A. k, locking parameter
  - B. d, grain diameter
  - C.  $\sigma_y$ , yield stress
  - D.  $\sigma_i$ , Frictional stress
14. Directional solidification can be used to produce
- A. Shape memory alloys
  - B. Fuel clad tubes for nuclear reactors
  - C. Materials for railway axles
  - D. Turbine blades for gas turbine engines

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

- A. Green density
- B. Theoretical density
- C. Sintered density
- D. Smear density

16. Grain boundary sliding is promoted by

- A. Elevated temperatures and low strain rate
- B. Elevated temperatures and high strain rate
- C. Sub zero temperatures and low strain rate
- D. Ambient temperature and high strain rate

17. Which of the following is a semiconductor material?

- A. Ge
- B. CdS
- C. GaP
- D. All the above

18. Approximate boiling temperature of liquid nitrogen at STP conditions is

- A. 273 K
- B. 77 K
- C. 4.2 K
- D. 10 K

19. One of the following is an inert gas electron configuration

- A.  $1s^2 2s^2 2p^1$
- B.  $1s^2 2s^2 2p^6$
- C.  $1s^2 2s^2 2p^6 3s^2 3p^2$
- D.  $1s^2 2s^1$

20. Primitive cell of face centered cubic structure contains the following number of atoms

- A. 4
- B. 2
- C. 1
- D. 3

21. For materials with uniform grain size distribution, the ASTM grain size is derived from the equation,  $n=2^{N-1}$  where n is the number of grains / inch<sup>2</sup>. During microscopic examination, the ASTM index is determined from the observations made at a magnification of

- A. 10 X
- B. 100 X
- C. 1000 X
- D. 10000 X

22. A positive edge dislocation can be visualized as

- A. Displacement of atoms from normal lattice positions into interstitial sites
- B. As closed vacancy loops in the crystal
- C. Insertion of extra half plane of atoms above the dislocation line
- D. Insertion of extra half plane of atoms below the dislocation line

23. Expansion of materials occurs during heating due to

- A. Only due to increase in lattice vibration amplitude
- B. Increase in lattice vibration amplitude and increase in vacancy concentration
- C. Increase in vacancy concentration
- D. Annihilation of vacancies

24. The following material shows well defined fatigue limit

- A. Mild steel
- B. Aluminum
- C. Alumina
- D. Copper

25. Oxide dispersion strengthened alloys are generally produced by

- A. Investment casting
- B. Electroslag remelting
- C. Rheocasting
- D. Mechanical alloying

## PART 'B'

26. The following elements contribute mainly to grain boundary strengthening in Ni base superalloys

- A. Aluminum, Titanium, Niobium
- B. Carbon, Boron, Zirconium
- C. Chromium, Aluminum
- D. Chromium, Molybdenum, Tungsten

27. The surface hardening process used for coating or cladding of a substrate for the purpose of reducing surface damage

- A. Hardfacing
- B. Carburizing
- C. Flame hardening
- D. Induction hardening

28. The product of complex number  $(4+2i)$  and  $(2+5i)$

- A.  $-4+20i$
- B.  $6+10i$
- C.  $-2+24i$
- D.  $2+24i$

29. Cottrell atmosphere is associated with

- A. Grain boundary shear
- B. Formation of vacancy loops
- C. Formation of slip band intrusion and extrusion
- D. Yield point phenomenon

30. The S-N curve in low cycle fatigue region is described by

- A. Goodman's relation
- B. Coffin-Manson relationship
- C. Basquin equation
- D. Soderberg equation



31. During primary creep

- A. Creep resistance of the material increases by virtue of its own deformation
- B. A balance between strain hardening and recovery process takes place
- C. Internal void formation occurs
- D. Recrystallization or diffusional changes in the phases occur

32. Residual stresses are

- A. Stresses above offset yield strength
- B. Elastic stresses
- C. Close to ultimate tensile strength
- D. Close to true fracture stress

33. The usage of failed tensile test samples is mandatory to evaluate the following:

- A. Yield strength and ultimate tensile strength
- B. Ductility and percentage reduction area
- C. Fracture strength and ultimate tensile strength
- D. Elastic modulus and proportional limit

34. Peritectic reaction is given by:

- A.  $\text{Liquid} + \text{Solid}_1 \rightarrow \text{Solid}_2$
- B.  $\text{Liquid}_1 + \text{Liquid}_2 \rightarrow \text{Liquid}_3$
- C.  $\text{Solid}_1 + \text{Solid}_2 \rightarrow \text{Liquid}$
- D.  $\text{Solid}_1 + \text{Solid}_2 \rightarrow \text{Solid}_3$

35. Millipede, a memory device based on a mechanical storage method uses an array of microcantilevers to create pattern of nanoindentation in a

- A. Polymer medium
- B. Molten salts
- C. Molten metal
- D. None of the above

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

- A. Formation of coherent precipitate platelets of  $\text{CuAl}_2$
- B. The occurrence of an equilibrium phase  $\text{CuAl}_2$
- C. Ordering of copper atoms on {100} planes of matrix
- D. Local clustering of copper atoms

37. The nuclear fuel in pressurized heavy water reactors in India is

- A. Oxides of Thorium and Plutonium
- B. Plutonium oxide
- C. Natural Uranium oxide
- D. Enriched  $\text{U}^{235}$

38. In fusion reactor based on the concept of magnetic confinement of plasma isotopes of the following are used for energy generation

- A. Plutonium
- B. Thorium
- C. Uranium
- D. Hydrogen

39. The following alloys are used as electrodes for resistance welding

- A. Cu-Cr
- B. Al-Si
- C. Cu-Zn
- D. Sb-Sn

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

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

41. 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)

42. Tabling process is unit operation for extraction of

- A. Lead
- B. Silicon
- C. Gold
- D. Copper

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

- A. Gibbs free energy is minimum
- B. Enthalpy is maximum
- C. Helmholtz's free energy is minimum
- D. Entropy is maximum

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

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

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

- A.  $180^\circ$
- B.  $136^\circ$
- C.  $90^\circ$
- D.  $0^\circ$

46. Cold working of a metallic material is carried out

- A. At its recrystallization temperature
- B. Below brittle to ductile transition temperature
- C. Above its recrystallization temperature
- D. Below its recrystallization temperature

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

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

48. Magnetically hard ferrites used for loud speakers, telephone ringers and receivers have the general formula  $MO.6Fe_2O_3$  where M is usually

- A. Ba or Sr ion
- B. Fe, Mn or Ni ion
- C. Fe or Si ion
- D. None of the above

49. The metallic materials that are widely being used for hip joints in human body are

- A. Niobium alloys
- B. Copper alloys
- C. Mild steel
- D. Titanium alloys

50. The condensed phase rule is represented by

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

51. The following has the highest co-efficient of thermal expansion

- A. Plastics
- B. Ceramics
- C. Tungsten
- D. Tin

52. Curie temperature is a useful concept for
- A. Ferro-magnetic material
  - B. Superplastic material
  - C. Ferro-elastic material
  - D. Dielectric material
53. Zinc has even number of electrons in the outer shell and a full valence band, therefore
- A. Zinc is an insulator
  - B. Zinc is a semi-conductor
  - C. Zinc is a conductor
  - D. None of the above
54. The neutron capture cross-section is customarily measure in barns. 1 barn equals to
- A.  $10^{-28} \text{ m}^2$
  - B.  $10^{-27} \text{ m}^2$
  - C.  $10^{-26} \text{ m}^2$
  - D.  $10^{-25} \text{ m}^2$
55. A small portion of In is incorporated in a Ge crystal. Ge crystal is now
- A. A conductor
  - B. An insulator
  - C. A n-type semiconductor
  - D. A p-type semiconductor
56. For continuous machining applications the following tool materials are primarily used
- A. High speed steel
  - B. Cast cobalt alloy
  - C. Cementite carbides
  - D. None of the above
57. The improvement in high cycle fatigue resistance of steel is obtained by having
- A. Surface decarburization
  - B. Fine grain size
  - C. Tensile residual stresses on surface
  - D. Presence of globular inclusions of oxides

58. Refinement of grain size in Magnesium alloys is carried out by the addition of

- A. Manganese
- B. Zinc
- C. Zirconium
- D. Cerium

59. Top-down approach is generally employed

- A. To activate the particles without altering the particle size of powders
- B. For increasing the particle size of powders
- C. For reducing the particle size of powders
- D. None of the above

60. Differential Scanning Calorimetry is used for the determination of

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

61. A very large Reynold's number is an indication of

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

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

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

63. A free radical can be best detected by

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

64. Which of the following statements is true?

- A. Reaction temperatures in plasma enhanced chemical vapor deposition are greater than in thermal chemical vapor deposition
- B. Reaction temperatures in plasma enhanced chemical vapor deposition are less than in thermal chemical vapor deposition
- C. Reaction temperatures in plasma enhanced chemical vapor deposition are equal to those in thermal chemical vapor deposition
- D. None of the above

65. The following technique has the ability to carry out precise and controlled manipulation of atoms, molecules and nanostructures

- A. X-ray photoelectron spectroscopy
- B. High resolution transmission electron microscope
- C. Scanning Tunneling Microscopy
- D. Optical microscopy

66. The relationship between Young's modulus ( $E$ ), modulus of rigidity ( $\eta$ ) and Poisson's ration ( $\nu$ ) is

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

67. The energy of neutrons that cause fission in thermal nuclear reactors is

- A. 14 MeV
- B. 25 keV
- C. 0.25 eV
- D.  $>0.1$  MeV

68. Presence of super-lattice line/peak in an x-ray diffractogram of a solid indicates the presence of

- A. Nucleation of precipitates
- B. Long range ordering
- C. Immiscibility of alloying elements
- D. Overaged precipitates

69. The total area under stress-strain curve represents

- A. Fracture strength
- B. Malleability
- C. Toughness
- D. Resilience

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

- A. Graphene layers
- B. Amorphous carbon thin films
- C. Crystalline diamond composites
- D. All of the above

71. Sensitization in stainless steels is associated with

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

72. In the superconducting state, the electrical resistivity of a material is

- A. One tenth its normal value
- B. Ten times the normal value
- C. Zero
- D. Unaltered

73. Perspex is a

- A. Metal
- B. Ceramic
- C. Gas
- D. Polymeric material

74. A material with zero co-efficient of thermal expansion is

- A. Invar
- B. Nd-B compound
- C. Tungsten
- D. Celluloid



75. Energy gap of Germanium at room temperature is

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