

# ENTRANCE EXAMINATIONS, JUNE 2010 QUESTION PAPER


## M.Tech./Ph.D.(Materials Engineering)

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:  



(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. Sound waves do not exhibit

- A. interference
- B. refraction
- C. polarization
- D. diffraction

2. 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

3. The force acting on a particle in one dimension is  $F = -2x - 6x^3$ . The corresponding potential energy  $V(x)$ , assuming  $V(0) = 0$ , is

- A.  $2x^2 - 6x^4$
- B.  $x^2 + (3/2)x^4$
- C.  $2x^2 + 6x^4$
- D.  $-x^2 - (3/2)x^4$

4. The type of atomic bonding most common in typical semiconductors is

- A. metallic
- B. covalent
- C. ionic
- D. hydrogen

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

- A. zero
- B. positive
- C. negative
- D. either positive or negative

6. The crystal structure of diamond is a variant of the

- A. the orthorhombic structure,
- B. the FCC structure
- C. monoclinic structure
- D. tetragonal structure

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7. A ternary peritectic reaction can be represented as

- A.  $L + \alpha + \beta \leftrightarrow \gamma$
- B.  $L + \alpha \leftrightarrow \beta + \gamma$
- C.  $L \leftrightarrow \alpha + \beta + \gamma$
- D.  $L + \beta \leftrightarrow L + \alpha + \gamma$

8. Flux coated electrodes are used in

- A. tungsten Inert Gas welding
- B. shielded metal arc welding
- C. submerged arc welding
- D. resistance welding

9. Malleable 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

10. At Equicohesive temperature

- A. grains are stronger than grain boundaries
- B. grain boundaries are stronger than grains
- C. both grains and grain boundaries are expected to have equal strength
- D. all the grains are of equal size

11. Progressive deformation of a material at elevated temperatures ( $>0.35 T_M$ ) under constant stress is called as

- A. fatigue
- B. ductility
- C. creep
- D. malleability

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12. Martensite obtained on quenching-in plain carbon steel with 0.55-0.6% carbon will have a hardness of:

- A. Rc 65
- B. Rc 10
- C. Rc 20
- D. Rc 35

13. In Hall-Petch equation,  $\sigma_y = \sigma_i + kd^{-1/2}$ , the relative hardening contribution of the grain boundaries is described by:

- A.  $\sigma_y$  (yield stress)
- B.  $\sigma_i$  (frictional stress)
- C. d, grain diameter
- D. k, locking parameter

14. The plastic flow curve in a tensile test of a ductile material is represented by the following equation:

- A.  $\epsilon = K \sigma^n$
- B.  $\sigma = K \epsilon^n$
- C.  $\dot{\epsilon} = K \sigma^n$
- D.  $\sigma = K \dot{\epsilon}^n$

15.  $dG/dP$  at constant temperature, for a closed system, is:

- A. entropy
- B. negative of entropy
- C. volume
- D. negative of volume

16. Face Centered Cubic materials will have the following stacking sequence:

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

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17. The primary requirement for age-hardening is

- A. a decrease in solubility of precipitating phase in the matrix with decrease in temperature
- B. an increase in solubility of precipitating phase in the matrix with decrease in temperature
- C. a decrease in solubility of the precipitating phase in the matrix with increase in temperature
- D. the ability of the coherent precipitates to coarsen rapidly

18. 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

19. Among the following types of power stations, which contributes the least to the global warming?

- A. a coal-fired power station
- B. a gas-fired power station
- C. a nuclear power station
- D. an oil-fired power station

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

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

21. An elemental superconductor is a perfect

- A. diamagnet
- B. ferromagnet
- C. dielectric
- D. paramagnet

22. The reciprocal lattice of a BCC lattice

- A. is a BCC lattice
- B. is a simple cubic lattice
- C. is a FCC lattice
- D. does not exist

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23. A Schottky defect is

- A. a point defect in ionic crystals
- B. a line defect in ionic crystals
- C. a point defect in metals
- D. a line defect in metals

24. The empirical relation that incorporates yield strength for describing the effect of mean stress on fatigue life is

- A. Gerber's relationship
- B. Goodman's relationship
- C. Soderberg's relationship
- D. Coffin-Manson relationship

25. The structural state of polymers can be in

- A. semi-crystalline
- B. amorphous
- C. liquid crystal
- D. all the above

**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. The concept of "Cottrell atmosphere" is useful in explaining

- A. strain ageing phenomenon
- B. shape memory effect
- C. Hall-Petch effect
- D. Raman effect

28.  $\beta$ -brass, CuZn (BCC) is

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

29. 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

30. Nernst equation is given by

- A.  $\Delta G = -nFE$
- B.  $\Delta E = -nFG$
- C.  $\Delta F = -nGE$
- D.  $\Delta S = -nGF$

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31. 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

32. Slip begins when the shearing stress on the slip plane in the slip direction reaches a threshold value called

- A. critical resolved shear stress
- B. Piers-Nabarro stress
- C. endurance limit
- D. 0.2% offset yield strength

33. "Flash" is associated with the following manufacturing process

- A. hot rolling
- B. cold extrusion
- C. wire drawing
- D. closed die forging

34. Vegard's law (that relates lattice constant ("a" for the alloy and "a<sub>0</sub>" for the element) and composition (X)) will have the form

- A.  $a = kX + a_0$
- B.  $a = kX$
- C.  $a = kX^2 + a_0$
- D.  $a^2 = kX + a_0$

35. The following are superalloys:

- A. Ti- based alloys
- B. Mo- based alloys
- C. Zr- based alloys
- D. Ni- based alloys



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36. The following direction lies in (111) plane

- A.  $[-1\ 0\ 1]$
- B.  $[1\ 0\ 0]$
- C.  $[0\ -1\ 0]$
- D.  $[1\ 1\ 1]$

37. The activation energy required for homogeneous nucleation is

- A. zero
- B. more than that of heterogeneous nucleation
- C. less than that of heterogeneous nucleation
- D. equal to that of heterogeneous nucleation

38. 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

39. Rotary swaging is a metal forming operation used to

- A. reduce the diameter of a rod
- B. reduce the thickness of a plate
- C. increase the diameter of a pipe
- D. make tubes of asymmetric shapes

40. Microstructure of steel produced by austempering

- A. bainite
- B. austenite
- C. pearlite
- D. martensite

41. Zirconium alloys are used widely for

- A. dental implants
- B. heat exchanger tubes of coal fired power plants
- C. gas turbine blades
- D. nuclear fuel clad tubes of thermal reactors

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

- A. super conductor
- B. semiconductor
- C. soft magnet
- D. dielectric material

43. Stress corrosion cracking occurs in Austenitic stainless steels when these are exposed to a tensile stress and

- A. chloride environment
- B. caustic environment
- C. mercury
- D. water

44. The following is not a point defect:

- A. vacancy
- B. interstitial
- C. impurity
- D. inclusion

45. At room temperature, the activation energy required for vacancy diffusion

- A. is more than that of interstitial diffusion
- B. is less than that of interstitial diffusion
- C. is equal to that of interstitial diffusion
- D. none of these

46. In the limit  $x \rightarrow \infty$ ,  $\ln x - x$

- A. equals zero
- B. equals 2
- C. equals  $-\infty$
- D. equals 1

47. Which of the following is not true for the dielectric constant of a material?

- A. it is frequency dependent
- B. it is frequency independent
- C. it is a complex quantity
- D. it is non-linear for ferroelectrics

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48. It is given that  $(\log_2 x)(\log_3 x)(\log_5 x) = (\log_2 x)(\log_3 x) + (\log_3 x)(\log_5 x) + (\log_5 x)(\log_2 x)$  and  $x \neq 1$ . Then  $x$  is

- A. 10
- B. 30
- C. 31
- D. 100

49. Let  $\alpha = 1! + 2! + 3! + \dots + 94!$ ; when  $\alpha$  is divided by 15 the remainder is

- A. 14
- B. 1
- C. 4
- D. 3

50. pH value of a solution containing equal concentrations of hydrogen and hydroxyl ions will be

- A. 0
- B. 10
- C. 7
- D. 14

51. Martensite transformation is an example of

- A. reconstructive transformation
- B. displacive transformation
- C. diffusion phase transformation
- D. massive phase transformation

52. Solid  $\text{CO}_2$  is called "dry ice" because

- A. the critical temperature of  $\text{CO}_2$  is above  $25^\circ\text{C}$
- B. the boiling point of liquid  $\text{CO}_2$  is above  $100^\circ\text{C}$
- C. at  $25^\circ\text{C}$  and 1 atm, only solid and vapor phases of  $\text{CO}_2$  are in equilibrium
- D. the melting point of liquid  $\text{CO}_2$  is above  $0^\circ\text{C}$

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53. Borax is used in preparing

- A. pyrex glass
- B. soda glass
- C. portland cement
- D. opal glass

54. Determinant of  $\begin{pmatrix} 3 & 1 & 2 \\ 1 & 2 & 1 \\ 3 & 1 & 2 \end{pmatrix}$  is

- A. 0
- B. 1
- C. 20
- D. -10

55. Fatigue fracture is identified by the presence of

- A. cavities on grain boundaries
- B. dimples on fracture surface
- C. pits on fracture surface
- D. striations

56. Scanning electron microscopy is not used for

- A. fractographic studies
- B. compositional studies
- C. polarization studies
- D. topographic studies

57. The unit for plane-strain fracture toughness

- A. MN/m
- B. MN/m<sup>2</sup>
- C. MN/m<sup>3/2</sup>
- D. MN/m<sup>1/2</sup>

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58. A method used to produce semiconductor grade material is

- A. floating zone refining
- B. laser ablation
- C. vacuum arc melting
- D. vacuum induction melting

59. In some polymers the elongated voids having a fibrous structure that develops is known as a

- A. shear zone,
- B. zone of segregation,
- C. craze zone
- D. none of the above

60. Hot working of a metallic material is carried out

- A. above its recrystallization temperature
- B. below its recrystallization temperature
- C. at its recrystallization temperature
- D. at its melting temperature

61. Wood is a naturally occurring

- A. refractory material
- B. composite material
- C. ceramic material
- D. malleable material

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

- A. stacking fault
- B. twin
- C. grain boundary
- D. screw dislocation

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63. 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

64. 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

65. Naturally occurring uranium ore contains

- A. fissile isotopes of uranium only
- B. fertile isotopes of uranium only
- C. both fissile and fertile isotopes of uranium
- D. fertile isotopes of both thorium and uranium

66. The hardening treatment that induces carbon and nitrogen simultaneously onto the surface of a steel component

- A. carburizing
- B. cyaniding
- C. nitriding
- D. flame hardening

67. The ceramic that can be used as a cutting tool

- A. yittria
- B. titania
- C. alumina
- D. magnesia

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68. A material used to make a thermocouple

- A. platinum-(platinum-rhodium)
- B. thoria dopped tungsten
- C. molybdenum disilicide
- D. super kanthal

69. During chain growth polymerization, the molecular weight of the polymer

- A. increases with conversion
- B. decreases with conversion
- C. does not change with conversion
- D. first increases and then decreases with conversion

70. The important design factor to be considered for automobile body is

- A. damping capacity
- B. crash worthiness
- C. creep
- D. fatigue

71. Phase transformations in metals and alloys can be determined by

- A. changes in hardness
- B. thermal analysis
- C. volumetric changes
- D. all the above

72. 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

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73. Hot isostatic pressing uses the combination of the following to produce preformed components

- A. elevated temperature and high pressure
- B. low temperature and high pressure
- C. high pressure only
- D. high temperature only

74. At room temperature, the following has the lowest toughness

- A. reinforced plastics
- B. thermoplastics
- C. thermosets
- D. glasses

75. 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