

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)**

CLASS: BTECH
BRANCH: MECH & PIE

SEMESTER : III
SESSION : MO/2022

SUBJECT: PE214 METALLURGICAL AND MATERIALS ENGINEERING

TIME: 3:00 Hours

FULL MARKS: 50

INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
 2. Attempt all questions.
 3. The missing data, if any, may be assumed suitably.
 4. Before attempting the question paper, be sure that you have got the correct question paper.
 5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.
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- Q.1(a) Write one-word answers for the following: [2] CO2 BL 2
- I. The required mill load increases in every successive pass during cold rolling of a metal sheet mainly because of _____ at a temperature below the _____
 - II. The crystalline defect that can explain both ease of deformation and strength of a metallic material is called _____, which is a/an _____ dimensional defect
- Q.1(b) Draw the following directions and planes within a cubic unit cell [3] CO1 3
- I. [101] IV. (002)
 - II. [122] V. (102)
 - III. [301] VI. (030)
- Q.1(c) Choose the correct option: [5] CO1 3
- I. The suitable technique for determining local composition of a phase in a given microstructure of a solid is:
 - A. transmission electron microscopy,
 - B. scanning electron microscopy,
 - C. X-ray diffraction,
 - D. photoelectron spectroscopy,
 - E. energy dispersive spectroscopy,
 - F. impedance spectroscopy
 - II. The ONLY two-dimensional crystalline defect listed below is:
 - A. dislocation,
 - B. stacking fault,
 - C. Frenkel defect,
 - D. inclusion,
 - E. interstitial atom,
 - F. kink
 - III. The MOST IMPORTANT property for designing a bullet proof armour shield is:
 - A. transparency,
 - B. compressive strength,
 - C. thermal conductivity,
 - D. hardness,
 - E. impact toughness,
 - F. fatigue strength
 - IV. The MOST IMPORTANT property for aircraft body fabrication is:
 - A. tensile toughness,
 - B. creep strength,
 - C. coercivity,
 - D. damping capacity,
 - E. high specific strength,
 - F. wear resistance
 - V. The MOST IMPORTANT property for production of a sheet metal to be used for making a thin door panel with complex geometry of a car body is:
 - A. impact strength,
 - B. oxidation resistance,
 - C. deep-drawability,
 - D. fatigue strength,
 - E. torsional strength,
 - F. erosive wear
- Q.2(a) Write one-line short answers to the following: [2] CO2 3
- I. Why does a grain boundary appear dark under an optical microscope?
 - II. Why are Frenkel and Schottky defects irrelevant in metals?

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- Q.2(b) Comment whether the variation is DIRECTLY or INVERSELY related between: [3] CO5 2
- I. Thermal conductivity (of a metal) and thermal gradient.
 - II. Hardness and degree of cold work.
 - III. Viscosity (of a polymeric solid) and isothermal temperature.
 - IV. Tensile strength (of a metallic alloy) and average grain diameter.
 - V. Diffusion coefficient and isothermal temperature.
 - VI. Driving force and diffusion coefficient.

- Q.2(c) Write the correct 'word' to FILL IN THE BLANK: [5] CO2 3
- I. Both edge and screw dislocations are line defects, but only _____ dislocations can cross slip.
 - II. Carbon as an interstitial solute has an option of choosing octahedral and tetrahedral void in BCC-iron but prefers _____ void as it is bigger in size or diameter.
 - III. Change in crystal lattice from BCC-titanium to HCP-titanium is called allotropic change but similar transformation of graphite by pressure to diamond (both elemental carbon) is called _____ change as the latter is irreversible.
 - IV. Diffusion coefficient of a solute atom through the internal grain boundary is likely to be _____ than that on the free surface of this crystal.
 - V. Both aluminium and diamond are elemental crystals with face centred cubic Bravais lattice, but _____ enjoys higher atomic packing density.

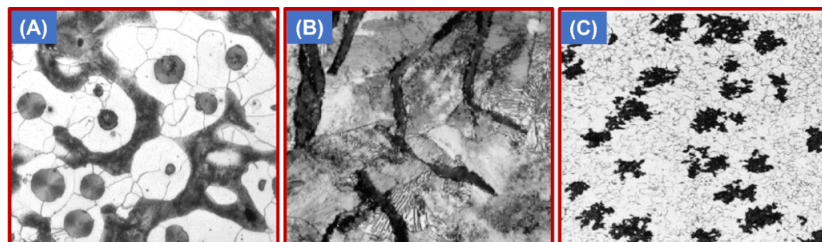
- Q.3(a) Calculate (i) the size of the critical radius and (ii) the number of atoms in the critical nucleus when solid copper forms by homogeneous nucleation. [2] CO3 3
 [Given for Cu latent heat of fusion is $965 \times 10^6 \text{ J/m}^3$, surface energy is $126 \times 10^{-3} \text{ J/m}^2$, undercooling for homogeneous nucleation is 236°C and lattice parameter is 0.4086 nm]

- Q.3(b) For a Fe-0.40 wt% C alloy at a temperature just below the eutectoid, determine the following: [3] CO2 3
- i. the proeutectoid phase that forms,
 - ii. the composition (names) and amount of each phase present at 728°C ,
 - iii. the composition (names) and amount of each phase present at 726°C

[assume eutectoid composition is 0.8 wt.% C and eutectoid temperature is 727°C]

- Q.3(c) Draw the partial, full or schematic phase diagram of a binary system showing: (i) isomorphous (ii) eutectic and (iii) peritectic changes. Label the phase/phases above, below or between the liquidus and solidus lines. [5] CO2 1

- Q.4(a) Select the correct option: [2] CO4 2
- I. Identify the correct sequence of the microstructures:



- a. (A) Grey cast iron, (B) Nodular cast iron, (C) White cast iron
- b. (A) Spheroidal Grey cast iron, (B) Grey cast iron, (C) Malleable cast iron
- c. (A) Spheroidal Gray cast iron, (B) Grey cast iron, (C) Austempered ductile iron
- d. (A) Nodular cast iron, (B) Gray cast iron, (C) White cast iron

- II. State the properties described by thermosetting plastics:
 - a. perfectly plastic,
 - b. rigid plastic,
 - c. perfectly elastic,
 - d. none of the above
- III. The deformation mechanism applicable only to polymeric and no other engineering solid is
 - a. Elastic deformation
 - b. Plastic deformation
 - c. Shear deformation
 - d. Viscoelastic deformation
- IV. Tendency of cracking during quenching and hardening of an alloy steel component can be reduced by:
 - a. austempering
 - b. tempering
 - c. nodularizing
 - d. martempering

Q.4(b) Answer very briefly: [3] CO4 2

- I. Explain a glass-ceramic.
- II. Elucidate the most important property of a refractory.
- III. Demonstrate why does conductivity of Si improve by doping with P or As.

Q.4(c) Write differences between (in one line only): [5] CO3 4

- I. Thermosetting and thermoplastic polymers
- II. Nodularizing and Malleablizing
- III. Primary and secondary hardening of steel
- IV. Annealing and normalizing of steel
- V. Fatigue and tensile testing of solids

Q.5(a) Define the following: (A) monomer, (B) copolymer [2] CO4 1

Q.5(b) Answer very briefly: [3] CO5 3

- I. Explain creep.
- II. Elucidate why does creep happens more at high temperatures.
- III. Describe the stages of creep deformation.

Q.5(c) I. Answer very briefly: What does resistivity depend on? How does it vary with temperature? [5] CO5 4

- II. Differentiate between:
 - (A) Soft and hard magnetism
 - (B) X-ray diffraction and X-ray spectroscopy

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