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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Third Semester, B.E. – Automobile Engineering

Semester End Examination; Dec. - 2014

Material Science and Metallurgy

Time: 3 hrs

Max. Marks: 100

- Note:** i) Answer **FIVE** full questions, selecting **ONE** full question from each Unit.
ii) Assume suitable missing data if any.

Unit - I

- 1 a. Write a short note on space lattice. Draw atomic arrangement in a planar surface imperfection with a boundary. 8
- b. Calculate the packing efficiency of a BCC structure. 4
- c. Copper has FCC structure. Its atomic radius is 1.278×10^{-8} cm. Atomic weight of copper is 63.5. Avogadro's number is $N = 6.02 \times 10^{23}$. Calculate its density. 4
- d. The unit cell of chromium is cubic and contains two atoms. Determine the dimensions of chromium unit cell. 4
- [Given atomic weight of chromium = 52 and density of chromium = 7.19 Mg/m^3].
- 2 a. The diffusivity of Ni atoms in the solid FCC Iron lattice is $1 \times 10^{-13} \text{ m}^2/\text{s}$ at 1300° C and $1 \times 10^{-6} \text{ m}^2/\text{s}$ at 1000° C . Calculate the activation energy in J/mole for diffusion of Ni atoms in the FCC Iron lattice in this temperature range. 4
- b. How do you distinguish between steady and non steady flow diffusion? State and explain Fick's II-law of diffusion. 8
- c. Explain different types of mechanism of diffusion in solids. 5
- d. Zirconium has an HCP crystal structure and a density of 6.51 g/cm^3 .
i) What is the volume of its unit cell in cubic meters? 3
ii) If the c/a ratio is 1.593, Compute the values of c and a.

Unit - II

- 3 a. Define engineering stress and strain and true stress and strain. Find out the relationship between true strain and engineering strain. 8
- b. Differentiate between slip and twinning deformation in materials. 6
- c. A cylindrical specimen of steel having an original diameter of 12.5 mm is Tensile tested to fracture and found to have engineering fracture strength of 450 MPa. If its cross – sectional diameter at fracture is 10.5 mm determine. 6
- i) The ductility in terms of percent area reduction.
- ii) True stress at fracture.

- 4 a. Write a note on ductile fracture. 5
- b. Define fatigue and explain mechanism of fatigue. 5
- c. What is Griffith's theory of brittle fracture? Derive the equation for critical stress for crack propagation. 7
- d. What are factors affecting the fatigue life. 3

Unit - III

- 5 a. Define Nucleation. Derive an expression for the critical size of nucleus for homogeneous nucleation. 8
- b. Lead melts at 323°C and Tin melts at 232°C. Additions of Tin to lead lowers melting point of lead and addition of lead to Tin lowers the melting point of Tin. At 180°C, liquid of composition 61.9% Tin, alpha (α) phase of composition 19.2% Tin and beta (β) phase of composition 96.2% Tin are in thermal equilibrium. The solubilities of lead in Tin and Tin in lead at room temperature are negligible draw the lead – tin phase diagram. 6
- c. What are invariant reactions? With neat sketch explain, Eutectic and Eutectoid reactions. 6
- 6 a. Explain Hume – Rothery rules for solid solution behavior. 5
- b. State Gibb's phase rule and explain the terms associated with it. 7
- c. Explain the steps to construct TTT diagram. Draw a sketch of a TTT diagram label all the fields for an eutectoid steel. 8

Unit - IV

- 7 a. Define the process of heat treatment and classify various heat treatment processes. 8
- b. Define hardenability of a material and list the factors affecting hardenability. 6
- c. List out the methods in case/surface hardening. Explain carburizing with a neat sketch. 6
- 8 a. Explain Austempering and Martempering of steels. 8
- b. Differentiate between normalizing and annealing. 6
- c. Write short notes on i) cyaniding ii) Nitriding. 6

Unit - V

- 9 a. Describe composition, properties and application of gray cast iron. 8
- b. Write short notes on Al-si alloys. 4
- c. Name the four important copper base alloys. Give composition, microstructure and their applications. 8
- 10 a. Define composite material. Mention the advantageous of composite materials over traditional materials. 6
- b. List the different methods of manufacturing FRP. Explain any two of them. 8
- c. Write short note on application of composites. 6