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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 - 2016/Jan - 2017

Material Science and Metallurgy

Time: 3 hrs

Max. Marks: 100

**Note:** Answer **FIVE** full questions, selecting **ONE** full question from each unit.

### UNIT - I

- 1 a. Draw the unit cell of BCC and FCC and find out the effective number of atoms and packing factor of each. 6
- b. State and explain the Fick's laws of diffusion. 6
- c. Classify and explain any two crystal imperfections. 8
- 2 a. What do you mean by linear and nonlinear elastic properties of a material? Explain any two properties briefly. 6
- b. Establish the relationship between engineering stress and the true stress also show the relationship of engineering strain and true strain. 6
- c. Consider a tensile specimen of 5 mm diameter and 25 mm gauge length. If its diameter is reduced to 4 mm through plastic deformation, what is its length at this stage? Also find engineering stress, true stress, engineering strain and true strain where load applied is 500 N. 8

### UNIT - II

- 3 a. What is S-N diagram? Explain its importance with the example of mild steel and Aluminum. 8
- b. List and explain the factors affecting fatigue life of a material. 6
- c. Draw the stress-strain diagram (Schematic) of mild steel and describe how the following properties can be obtained from the curve; 6
  - i) Young's Modulus
  - ii) Ductility
  - iii) Fracture strength.
- 4 a. With a neat sketch, explain the three stages of creep. 8
- b. A fatigue test is made with mean stress,  $\sigma_m = 120$  MPa and stress-amplitude,  $\sigma_a = 165$  MPa. Find  $\sigma_{max}$ ,  $\sigma_{min}$ ,  $\sigma_{range}$ , and  $\sigma_{ratio}$ . 6
- c. Distinguish between ductile and brittle fracture. 6

### UNIT - III

- 5 a. Explain the mechanism of solidification. 6
- b. What is a solid solution? Mention the types of solid solution. Also enumerate Hume-Rothery rules governing the formation of solid solution. 8

- c. What are invariant reactions? Explain with a neat sketch the following invariant reactions : 6  
 i) Eutectic      ii) Peritectic.
- 6 a. Draw a neat sketch of Iron-Carbon equilibrium diagram and label the fields and explain the 10  
 solidification of hypo Eutectoid steel.
- b. Two metals A and B have their melting points at 900°C and 800°C respectively. The alloy 10  
 pair forms a eutectic at 600°C of composition 60% B. They have unlimited liquid  
 solubilities. The solid solubility of A in B is 10% and that of B in A is 5% at eutectic  
 temperature and remains constant till 0°C. Draw the phase diagram. Find the amount of  
 liquid and solid phases in an alloy of 20% B at 650°C.

#### UNIT - IV

- 7 a. What do you understand by the term 'Heat treatment' and what are its objectives? 6  
 b. Explain the following heat treatment process :  
 i) Annealing 6  
 ii) Normalizing.
- c. Discuss the process of surface Hardening by Nitriding and its advantages. 8
- 8 a. With sketch, distinguish between Austempering and Martempering. 6  
 b. Distinguish between the hardness and hardenability of steel. Briefly explain the method of 8  
 determination of hardenability of steel.
- c. Classify the methods of case hardening and explain any two methods. 6

#### UNIT - V

- 9 a. Explain the structure, composition and properties of gray iron, malleable cast iron, SG iron. 10  
 b. Mention the composition, properties and uses of;  
 i) Bronze 10  
 ii) 18-8 stainless steel  
 iii) Al-Si alloy.
- 10 a. What is composite material? Classify the composite materials based on matrix, geometry of 10  
 reinforcement materials and briefly explain it.
- b. Explain with a neat sketch, the pultrusion process and mention its applications. 10

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