

1128  
M. Tech. (Material Science and Technology)  
First Semester  
MST-101: Materials and their Properties

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Unit.

x-x-x

- I. Attempt the following briefly:-
- a) What is "Life Fraction Rule" for fatigue state?
  - b) Briefly explain why ceramic materials are, in general, brittle materials.
  - c) How polymers are classified on the basis of structure?
  - d) What is the difference between an engineering stress-engineering strain curve and a true stress-true strain curve? Which is easier to determine experimentally?
  - e) Does thermodynamic analysis of rubber elasticity apply to rubber in compression? Explain. (5x2)

UNIT - I

- II. a) What is carburization of steel? Explain why this process is important.  
b) (i) Describe the structure of HCP crystal, (ii) Calculate the axial ratio (c/a) and atomic packing fraction of HCP structure. (5,5)
- III. a) A plate of iron is exposed to a carburizing atmosphere on one side and decarburizing atmosphere on the other side at 800° C. If a condition of steady state is achieved, calculate the diffusion flux of carbon through the plate if the concentration of carbon at positions of 5 mm and 10 mm beneath the carburizing surface are 1.2 and 0.8 kg/m<sup>3</sup> respectively. Assume a diffusion coefficient of 3x10<sup>-11</sup> m<sup>2</sup>/s at this temperature.  
b) Prove that the minimum cation-to anion radius ratio for the coordination number 3 is 0.155.  
c) Explain why an elastomer under tensile load contracts on heating. Compare this with the behavior of ordinary materials. (3,3,4)

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(2)

- IV. a) What is visco-elasticity? How do you understand this phenomenon using the spring dashpot model.
- b) (i) Mention the main differences between ionic, covalent and metallic bonding- (ii) Explain why hydrogen fluoride (HF) has a higher boiling temperature than hydrogen chloride (HCl) even though HF has a lower molecular weight. (5,5)

### UNIT - II

- V. a) Discuss the role of (i) grain boundaries and (ii) precipitate particles, in strengthening crystalline materials against yield at low as well as at high temperatures of deformation.
- b) Explain the differences in approaches used by Einstein and Debye theory to explain the specific heat of the solids. (5,5)
- VI. a) How can creep damage of a microstructure be analyzed? What is the procedure and what are the typical microstructural features?
- b) What are some common applications in which a luminescence sensor is used?
- c) Mention two methods of decreasing the depression in the beam which is loaded with weight in the middle. (5,3,2)
- VII. a) Explain the differences between an edge and screw dislocations. Which of these can cross slip?
- b) Account qualitatively for the reddish color of copper, given that copper has an electronic configuration of  $3d^{10}4s^1$ .
- c) Explain why there is an increased stress near the edge of a crack? Would the stress concentration be higher for a sharp crack or a blunt crack? (3,3,4)

x-x-x