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B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Third/Fourth Semester

Mechanical Engineering

ME 3392 — ENGINEERING MATERIALS AND METALLURGY

(Common to : Manufacturing Engineering/Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering)

(Regulations 2021)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. In the pure water pressure — temperature phase diagram, name the phases that are in equilibrium: (a) along the fusion curve, (b) along the vapourisation curve and (c) at the triple point.

2. Calculate the number of Frenkel defects per cubic meter in Silver Chloride at 350°C. The energy for defect formation is 1.1 eV, while the density for AgCl is 5.50 g/cm^3 at 350°C.

3. Why are martensitic transformations called athermal transformations in steels?

4. Define eutectic and eutectoid points in Fe-C phase diagram.

5. Distinguish between alpha and beta stabilizers.

6. What are the ways by which the sensitization problem is overcome in stainless steels?

7. What is the effect of addition of filler sin polymers?

8. Enumerate the functions of matrix phase in a composite material.

9. How does the dislocations influence the strength of a material?

10. What is the general difference in strengthening mechanism between large particle and dispersion strengthened particle reinforced composites?

PART B — (5 × 13 = 65 marks)

11. (a) Discuss in detail the mechanism of formation of pearlite from austenite with neat schematic diagrams.

Or

(b) Explain in detail the procedure involved in the construction of the Isomorpous phase diagram Explain them with an example and draw the neat phase diagram.

12. (a) Describe the precipitation sequence in Al-4% Cu alloy while subjecting the alloy to age-hardening heat treatment.

Or

(b) For a eutectoid steel, describe an isothermal heat treatment that would be required to produce a specimen having a hardness of 03 HRB.

13. (a) (i) What are Super alloys? (3)

(ii) Discuss in detail the mechanism involved in the Superalloys that makes the alloy suitable for high temperature applications. (10)

Or

(b) (i) How are Cast irons classified based on the fractured surface and phase constituents? (3)

(ii) Discuss in detail the thermal cycle involved in the production of malleable cast iron from white cast iron. (10)

14. (a) (i) Derive a generalized expression for the transverse modulus of elasticity of an aligned hybrid composite consisting of two types of continuous fibers. (8)

(ii) What are the functions of faces and core in sandwich panels? (5)

Or

(b) Briefly explain the following alloys with respect to their composition, properties and applications.

(i) Kanthal (3)

(ii) Nichrome (3)

(iii) Boron nitride (4)

(iv) Manganin (3)

15. (a) What are the deformation mechanisms that are encountered in metallic materials? Discuss any one of the deformation mechanism in detail.

Or

(b) (i) What are the sources of residual stresses? Explain briefly the various ways by which the residual stresses can be eliminated. (8)

(ii) Distinguish between dendrite, columnar and equiaxed grains. (5)

PART C — (1 × 15 = 15 marks)

16. (a) (i) An Fe-C alloy of eutectoid composition (0.76 wt% C) is subjected to equilibrium cooling from austenitic region to room temperature. Discuss on the microstructural changes that take place during cooling. (8)

(ii) Draw an illustrative eutectic phase diagram and write down the eutectic reaction (with respect to the figure). What is a typical microstructure obtained, when a eutectic composition is slowly cooled? (7)

Or

(b) Construct the hypothetical phase diagram for metals A and B between room temperature (25°C) and 850°C. Given are the following information.

- The melting temperature of metal A is 520°C.
- The maximum solubility of B in A is 4 wt% B, which occurs at 480°C.
- The solubility of B in A at room temperature is 0 wt% B.
- One eutectic occurs at 480°C and 18 wt% B-82 wt% A.
- A second eutectic occurs at 515°C and 42 wt% B - 58 wt% A
- The intermetallic compound AB exists at a composition of 30 wt% B-70 wt% A, and melts congruently at 600°C.
- The melting temperature of metal B is 650°C.
- The maximum solubility of A in B is 13 wt% A, which occurs at 515°C.
- The solubility of A in B at room temperature is 3 wt% A.

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