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Question Paper Code : 80911

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

Third/Fourth Semester

Mechanical Engineering

ME 8491 – ENGINEERING METALLURGY

(Common to: Automobile Engineering / Manufacturing Engineering /
Mechanical and Automation Engineering / Production Engineering)

(Regulations 2017)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Enumerate the factors that govern the formation of substitutional solid solution.

2. Calculate the relative amount of ferrite and cementite in a steel containing 0.8%.

3. Stress relief annealing is an important Heat treatment Process for engineering components- Comment.

4. Draw the microstructures of an annealed and normalized steel containing 0.8 % Carbon.

5. Distinguish between alpha and beta stabilizers.

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

7. Composite materials are replacing metallic materials in many engineering applications – comment.

8. List the characteristics of PMMA polymers and it's advantageous over other transparent polymers.

9. Enumerate the various factors that affect the fatigue strength of a material.

10. Why the strength of brittle materials is much lower than predicted by theoretical calculations?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Show that the atomic packing factor for HCP is 0.74 and c/a ratio is 1.633. (8)

    (ii) Niobium has an atomic radius of 0.1430 nm and a density of 8.57 g/cm³. Determine whether it has a FCC or BCC crystal structure. (5)

Or

    (b) How are the liquidus and solidus lines plotted in an Isomorphous phase diagram? Explain them with an example and draw the neat phase diagram.

12. (a) (i) Continuous Cooling transformation diagrams are of most industrial importance than Isothermal transformation diagrams. Why? (3)

    (ii) Draw a typical TTT diagram for eutectoid steel and explain the various – phase fields. (10)

Or

    (b) (i) Why Post carburizing heat treatment is necessary for case hardened parts? (3)

    (ii) Discuss the three main types of carburising processes with the chemical reactions. (10)

13. (a) (i) Write down the differences between Phosphor bronze and aluminium bronze with respect to composition, properties and application. (7)

    (ii) What are the characteristics of aluminium and its alloys? (3)

    (iii) What is duralumin? What is the recent development in the alloy for aircraft bodies application? (3)

Or

    (b) Explain the composition, properties and applications of following alloy steels:

    (i) Ferritic stainless steels (3)

    (ii) Martensitic stainless steels (3)

    (iii) Austenitic stainless steels (3)

    (iv) Precipitation hardenable stainless steels (4)

14. (a) (i) Enumerate the parameters and conditions of the polymer molecular structure that affect the tribological characteristics of polymers. (4)

(ii) Discuss in detail the following with respect to polymers. (3 × 3 = 9)

(1) Viscoelasticity

(2) Surface energy

(3) Transfer film

Or

(b) (i) How does the amount of crystallinity in a thermoplastic affect its density and tensile strength? (4)

(ii) Write short notes on the following: (3 × 3 = 9)

(1) Tungsten carbide

(2) Cermets

(3) Boron nitride

15. (a) (i) Explain the following mechanisms: (9)

(1) Dislocation Climb

(2) Vacancy Diffusion

(3) Grain Boundary Sliding

(ii) Describe how the notch toughness is determined by using Charpy's and Izod's impact tests. (4)

Or

(b) Discuss in detail how the fine grain structure and the presence of particles in materials contributes to strengthening. Explain the mechanisms involved.

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) The following data have been obtained for a binary alloy system made up of components A and B.

Melting point of A = 660 °C

Melting point of B = 1430 °C

There is an invariant reaction occurring at 577 °C and the compositions involved are α (1.65 wt. % B), liquid (11.8% B) and pure B.

The solubility of B in A varies as follows:

350°C – 1.65%, 550°C –1.30%, 500 °C – 0.8%, 450°C – 0.48%, 400°C – 0.29%, 350°C – 0.17%.

A is insoluble in B at all temperatures.

Construct the binary diagram labeling the phases in various regions. (7)

Or

(b) (i) Enumerate the methods that are used to obtain good surface hardness and impact resistance of the core. (3)

(ii) Suggest a suitable heat treatment for an alloy steel containing nitride forming element to get good surface hardness and explain the process. (12)