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B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

Third/Fourth Semester

Manufacturing Engineering

ME 3392 – ENGINEERING MATERIALS AND METALLURGY

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

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Calculate the relative amount of ferrite and cementite in steel containing 0.8%.
2. In the pure water pressure-temperature phase diagram, name the phases that are in equilibrium: (a) along the fusion curve, (b) along the vapourization curve and (c) at the triple point.
3. Why are ferritic and austenitic stainless steels not heat treatable?
4. Why heat treatment is done on engineering materials?
5. Suggest a suitable metal or alloy for high-temperature furnace elements to be used in oxidizing atmospheres.
6. Write down the differences between 'Invar' and 'Elinvar'.
7. Enumerate the factors that affect the crystallinity of the polymers.
8. PZT are considered superior to $BaTiO_3$ piezoelectric materials. Give reasons.
9. How does the dislocation influence the yield strength of a material?
10. What is the effect of grain size on the creep strength of a material?

PART B — (5 × 13 = 65 marks)

11. (a) Draw the steel region of the Fe- Fe_3C phase diagram and make neat sketches of the microstructures expected for 4 compositions between 0.1 % and 1.2 % C.

Or

(b) What are solid solutions? Explain with neat sketches the types of solid solutions.

12. (a) Draw and explain the CCT diagram of eutectoid steel. In what way it differs from the TTT diagram of eutectoid steel?

Or

(b) Explain the following heat treatments with neat thermal cycle diagrams:

(i) Austempering (6)

(ii) Carburising (7)

13. (a) Compare gray and malleable cast irons with respect to

(i) composition and heat treatment (4)

(ii) microstructure (3)

(iii) mechanical characteristics (3)

(iv) applications (3)

Or

(b) Write down the differences between phosphor bronze and aluminium bronze with respect to composition, properties and application.

14. (a) (i) Differentiate between addition polymerisation and condensation polymerization. (7)

(ii) Write the properties, structure and applications of any two polymers. (6)

Or

(b) (i) Make comparisons of thermoplastic and thermosetting polymers on the basis of mechanical characteristics upon heating and according to possible molecular structure. (6)

(ii) Discuss the applications of composite materials. (7)

15. (a) What is Creep? Describe the different stages of a Creep curve with a neat sketch.

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) Construct the hypothetical phase diagram for metals A and B between room temperature (20° C) and 700° C. Given are the following information. And Explain the various invariant reactions.

(i) The melting temperature of metal A is 480°C.

(ii) The maximum solubility of B in A is 4 wt% B, which occurs at 420°C.

(iii) The solubility of B in A at room temperature is 0 wt% B.

(iv) One eutectic occurs at 420°C and 18 wt% B-82 wt% A.

(v) A second eutectic occurs at 475°C and 42 wt% B-58 wt% A.

(vi) The intermetallic compound AB exists at a composition of 30 wt% B -70 wt% A, and melts congruently at 525°C.

(vii) The melting temperature of metal B is 600°C.

(viii) The maximum solubility of A in B is 13 wt % A, which occurs at 475° C.

(ix) The solubility of A in B at room temperature is 3 wt % A.

Or

(b) Below is a list of metals and alloys: (5 × 3 = 15)

Plain carbon steel, Nickel Metal Hydride, Magnesium, Duralumin, Brass, Zinc, Gray cast iron, Tool steel, Aluminum, Stainless steel, Tungsten and Titanium alloy. Select from this list any 5 metal or alloy that is best suited for each of the following applications and cite two reason for your choice:

(i) The block of an internal combustion engine

(ii) Condensing heat exchanger for steam

(iii) Jet engine turbofan blades

(iv) Drill bit

(v) Cryogenic (i.e., very low temperature) container.