



KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS TREATED AS EXAM MALPRACTICE

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. a) What are the conditions for the dendritic growth? Explain why cast Mg-Li alloy is not preferred for aerospace application? [6]
b) Draw and calculate the linear and planar atomic density of the closely packed direction and plane of alpha iron. The lattice constant is 0.312 nm [4]
2. a) Derive the relationship between the applied tensile stress and the shear stress acting in the slip direction during the plastic deformation of single crystalline material. [6]
b) An iron rod has a grain size of 0.01 mm and yield strength of 230 MPa. The strength is 275 MPa at a grain size of 0.006 mm. In order to achieve a yield strength of 310 MPa what should be the grain size? [4]
3. a) Draw and explain Fe – Fe₃C phase diagram. Explain the various invariant reactions observed at different temperatures. Why there exist the differences in the solubility of carbon in δ , γ and α - Fe at different temperatures? [7]
b) Why plain high carbon steels are not preferred for making the high-performance cutting tools in spite of possessing the reasonable mechanical properties? [3]
4. a) Discuss the sensitization in austenitic stainless steels. Explain the phenomena, its effect and the remedial solutions. [5]
b) How does the microstructure of gray Cast Iron and nodular Cast Iron differ? How does this difference affect their mechanical properties? [5]
5. a) Derive the relationship between engineering stress strain and true stress strain. During the tension test of a typical ductile material, why there is a drop in the stress value with the increase in strain value beyond ultimate tensile strength. [6]
b) A cylindrical rod of superalloy is to be subjected to a tensile load of 50 kN. The initial length and diameter of the rod is 115 and 6 mm, respectively. It was noticed that the material elongated to 140.2 mm. Calculate the % elongation, engineering stress and true stress. [4]

6. Discuss the various stages involved during the ductile fracture of materials subjected to mechanical loading with suitable diagrams. Whether a ductile material undergo brittle mode of fracture. If so, enumerate the reasons. [10]
7. Why do materials fail at high temperature? Discuss the stages in creep and with a neat graph. How do you differentiate creep and stress rupture? Write the inference drawn from the creep studies? [10]
8. List any five of the advanced ceramics used for defense and manufacturing applications. Highlight the properties and characteristics of any ceramics in detail. [10]
9. (i) 0.18 % plain carbon steel in annealed condition has 25% coarse pearlite. If it is subjected to normalizing what changes would you expect in its microstructure? Also, what are the properties that enhance after subjecting to normalizing? [3+3+4]
- (ii) A thin strip of 1.1% carbon steel is quenched in water from its fully austenitic state. What structure would you expect in this steel? What is the nature of the final steel? Why?
- (iii) If a piece of steel having 0.2% carbon is quenched after soaking at a temperature just above A₁ what type of structure will you get? Estimate approximate constituents of phases present and their compositions.
10. a) Determine the undercooling temperature for homogeneous nucleation if the number of atoms in the critical nucleus for Iron (Fe) is 734. Given: The melting temperature of Fe is 1538°C, heat of fusion 1737 J/cm³, solid-liquid interfacial energy 204×10^{-7} J/cm², and lattice parameter for Fe 2.85 Å. [7]
- b) Explain the Fick's first law of diffusion with the help of an appropriate diagram. [3]
11. Explain how fatigue life assessment of the structural components is carried out in the lab scale? What is the importance of endurance limit? Explain the low and high cycle fatigue tests with suitable examples. [10]
12. a) Classify composite materials on the basis of i) type of reinforcement and ii) type of matrix phase. [6]
- b) What are the advantages and drawbacks of metal matrix composites over polymer matrix composites? [4]

