Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: ME210

Course Name: METALLURGY AND MATERIALS ENGINEERING

(MC, MP, MA, ME, PE)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) Explain with neat sketches the mechanism of dislocation and twinning as related to plastic deformation. (4)

b) What are Miller Indices? Sketch (101), (110), (011) planes on a cubic unit cell. (6)

2 a) Define critically resolved shear stress. (3)

b) A single metal crystal is oriented such that the normal to the slip plane and the slip direction are at angles of 43.1° and 47.9°, respectively, with the tensile axis. If the critical resolved shear stress is 20.7 MPa, will an applied stress of 45 MPa cause the single crystal to yield? If not, what stress will benecessary? (4)

c) Is iron an allotropic metal? Explain. (3)

3 a) How are yield strength and grain size of a crystal related? (3)

b) Yield strength of mild steel with an average grain size of 0.05mm is 138MPa and with a grain size of 0.007mm is 276MPa. What will be the average grain size for the same steel for yield strength of 207MPa? (3)

c) What is the significance of Burgers vector and Frank Read source in dislocation? (4)

4 a) Explain the Fick's laws of diffusion. (4)

b) An iron plate is exposed to a carburising atmosphere on one side and a decarburising atmosphere on other side at 720ºC. If a steady state condition is achieved, calculate the diffusion flux of carbon through the plate if the concentrations of carbon at positions of 6mm and 11mm beneath the carburising surface are 1.22 kg/m^3 and 0.82 kg/m^3 respectively. Assume a diffusion coefficient of 3.2×10^{11} m^2/s at this temperature. (6)

PART B

Answer any three full questions, each carries 10 marks.

5 a) Sketch and label the Iron-Carbon equilibrium diagram and explain the three equilibrium reactions in it. (6)

b) Copper (melting point 1083ºC) and silver (melting point 961ºC) form an alloy system which has partial solubility in the solid state. The mutual solubility of silver in copper is 7.9% and that of copper in silver is 8.8% at a eutectic temperature of 779ºC. The eutectic alloy has 71.9% silver. Sketch and label the phase diagram for Cu-Ag alloy system. (4)

6 a) Most cast alloys are reheated to a temperature below solidus after the solidification is completed. Why? (3)

b) What is the significance of critical cooling rate for an iron-carbon alloy system? (3)

c) Differentiate between martempering and austempering from the process point of view and the final microstructure point of view. (4)

7 a) What is work hardening? What is the effect of work hardening on mechanical properties of a metal? (4)

b) Explain the various stages and changes in properties when a severely cold worked metal is annealed at successive high temperatures. (6)

8 a) What is the fundamental difference between steel and cast iron? (3)

b) What are the different types of cast iron? How do they differ from each other? Compare the structure, properties and uses of any two types of cast iron. (7)

PART C

Answer any four full questions, each carries 10 marks.

9 a) Define endurance limit and fatigue strength reduction factor. (6)

b) Usually there is a poor correlation between the fatigue strength obtained from lab tests and the actual service failure. Why? (4)

10 a) What are the various stages in fatigue failure? (5)

b) What is ductile to brittle transition? Which material property is of importance in this phenomenon? Explain with the help of a relevant graph. (5)

11 a) How is the discrepancy between the fracture strength of a real material and its theoretical value explained by Griffith's crack theory? (6)

b) A sample of glass has a crack of length 4μm. Young's modulus of glass is 70GN/m^2 and specific surface energy is 1J/m^2. Find its fracture strength and compare it with the Young's Modulus. (4)

12 a) How does creep differ from fatigue? Sketch a typical creep curve and explain it. (7)

b) Write a note on creep resistant materials. (3)

13 a) What is super plasticity? What is the importance of strain rate sensitivity in this phenomenon? (5)

b) What is a composite material? What are the roles played by matrix phase and fiber phase in a composite? (5)

14 Quoting examples, explain the following (10)

i) Super alloys

ii) Smart materials

iii) Ceramic materials

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