Indian Institute of Technology Kharagpur
Department of Metallurgical and Materials Engineering

Class Test

Full marks: 20

Time: 55 minutes

Subject Name: Materials Engineering (MT30001)

No. of Students: 171

Instructions: Answer any four questions. Be specific and to the point in your answer.

1. [3+2]

(a) Determine the tensile stress that need to be applied along the [1-10] axis of a silver crystal to cause slip on the (1-1-1)[0-11] system. The CRSS is 6 MPa.

(b) If the true-stress-true-strain curve is given by the relationship: $\sigma = 1400\varepsilon^{0.33}$, where stress is in MPa, what is the ultimate tensile strength of the material?

2. [2+3]

(a) State the Griffith theory of fracture for brittle material?

(b) A relatively large plate of a glass is subjected to a tensile stress of 40 MPa. If the specific surface energy and modulus of elasticity for this glass are 0.3 J/m^2 and 69 GPa, respectively, determine the maximum length of internal flaw that is possible without fracture.

3. [2+3]

(a) Draw a typical TTT diagram of eutectoid steel and schematically superimpose on it the cooling rate of *normalizing* treatment to show the transformation product of austenite.

(b) Describe briefly the microstructural changes that happen during three stages of tempering treatment.

4. [2+3]

(a) State the Fick's first law of diffusion.

(b) Methylene chloride is a common ingredient of paint removers. Besides being an irritant, it also may be absorbed through skin. When using this paint remover, protective gloves should be worn. If butyl rubber gloves (0.04 cm thick) are used, what is the diffusive flux of methylene chloride through the glove? Given, diffusion coefficient in butyl rubber: $D = 110 \times 10^{-8}$ cm^2/s, surface concentrations: $C_1 = 0.44$ g/cm^3, $C_2 = 0.02$ g/cm^3.

5. [2+3]

(a) What is plane strain fracture toughness (K_{IC})?

(b) What is ductile to brittle transition temperature (DBTT)? Why BCC metal generally shows DBTT?