Registration No. : | | | | | | | | | | |

Total number of printed pages – 3

B. Tech

PCMT 4302

Fifth Semester Examination – 2013

DEFORMATION BEHAVIOUR OF MATERIALS

BRANCH : MM, MME

QUESTION CODE : C-343

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

(a) How is the maximum shear stress related to the principal normal stresses in a body subjected to a plane stress situation ?

(b) Define true strain in terms of engineering strain.

(c) What is the role of stacking fault energy on cross-slip ?

(d) Prove that the c/a ratio for ideal packing in the case of hexagonal close-packed structure is 1.633.

(e) Consider a Fe-C steel bar first strained plastically by loading to a point beyond the yield stress, then unloaded, and then reloaded several weeks later or given a moderate temperature aging treatment prior to being reloaded. What would be the stress-strain response of the reloaded steel bar?

(f) State briefly how the degree of strengthening resulting from second phase particles depends on the distribution of particles in the ductile matrix.

(g) What are the slip systems in FCC structure ? And how many slip systems are there in FCC lattice.

(h) What is critical resolved shear stress for slip ? How does it depend on composition ?

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(i) When plastic deformation (slip) in one direction is followed by deformation (slip) in the opposite direction then how does it affect the stress strain curve and the yield stress ?

(j) What is Burgers vector ? How is the Burgers vector of an edge dislocation determined?

2. (a) A tensile specimen having 2.5 cm length and 0.25 cm diameter is stretched uniformly to 3 cm, where it begins to neck under a load of 1400 N. Calculate the engineering stress, true stress, engineering strain and true strain at necking. 5

(b) Develop the elastic stress-strain relations for a three-dimensional state of stress considering a unit cube subjected to normal stresses σ_x, σ_y, σ_z and shearing stresses T_{xy}, T_{yz}, T_{zx}. 5

3. (a) Explain the Von Mises' and Tresca criteria for predicting the conditions at which plastic yielding begins when a material is subjected to any possible combination of stresses. 5

(b) Find the principal stresses and the orientation of the axes of principal stress with the x, y axes for the following situation. $\sigma_x = 340$ MPa, $\sigma_y = 34$ MPa and $T_{xy} = -55$ MPa. Construct a Mohr's circle of stress for the above given plane-stress condition. 5

4. (a) Explain slip by dislocation movement and the importance of dislocation width. 5

(b) Explain deformation by twinning with suitable sketches. How twinning differs from slip ? What are the different types of twins and under what conditions are they produced ? 5

5. (a) Consider the following face centered cubic dislocation reaction :

$$\left(\frac{a}{2}\right)[110] \rightarrow \left(\frac{a}{6}\right) + \left[21\bar{1}\right] + \left(\frac{a}{6}\right)[121]$$

Prove that the above dislocation dissociation reaction will occur. What kind of dislocations are the $\left(\frac{a}{6}\right)(121)$? What kind of crystal imperfection results from this dislocation reaction? What determines the distance of separation of the $\left(\frac{a}{6}\right)[211]$ and the $\left(\frac{a}{6}\right)[121]$ dislocations ? 5

(b) Explain through neat sketches the multiplication of dislocations by the operation of Frank Read sources. 5

6. (a) Explain yield point phenomenon and discuss why some metals show a sharp transition from elastic to plastic deformation. 5

(b) Explain with the help of neat sketches the intersection of two edge dislocations with Burgers vector at right angles to each other. 5

7. (a) Explain Griffith theory of brittle fracture and derive the expression for fracture stress under plane stress and plane strain conditions. 5

(b) Draw the engineering stress-strain curve of a typical metal and explain the significant points on the curve. Make a comparison of the stress-strain curves of a high carbon spring steel and a structural steel. 5

8. Write short notes on any **two** of the following : 5×2

(a) Stacking faults.

(b) Edge and Screw dislocations

(c) Dislocation climb

(d) Strengthening from grain boundaries.