B. E. (Met) Part IV, 8th Semester, May 2014

Fracture Mechanics and Failure Analysis

(MT 805/1)

Time: 3 h **Full marks: 70**

Answer ALL questions.

1. Indentify the correct answer: **(2×5 =10)**

(i) In fracture mode-II, fracture surfaces

(a) shear parallel to edge of crack
(b) shear perpendicular to edge of crack
(c) displace normal to each other
(d) none

(ii) Fracture toughness, K_{IC}, decreases with

(a) increasing temperature
(b) increasing strain rate
(c) increase in yield strength
(d) increase in grain size

(iii) If the surface crack causing fracture in a brittle material is made twice as deep, the fracture strength will

(a) decrease by a factor of $\sqrt{2}$
(b) decrease by a factor of 2
(c) decrease by a factor of 2^2
(d) no change

(iv) In a stressed body, the principle stress is

(a) the maximum shear stress in the body
(b) a normal stress acting perpendicular to the x,y and z planes.
(c) normal stress acting on the principle plane.
(d) the stress required to generate onset of plastic deformation

(v) Mobile jogs are

(a) Frank partial dislocations
(b) Lomer-Cottrell barrier
(c) Kinks
(d) Forest dislocation

2. Justify or refute the following (any *THREE*): **(5×3=15)**

(a) Finer particles increase the fracture stress more effectively than the coarser one.

(b) Plain strain situation is better represented by distortion energy criteria

(c) Compliance does not change under displacement and load controlled test.

(d) Fatigue strain life curve is varies from plastic to elastic nature with increasing number of reversals.

3. Answer the following (any TWO): **(10×2=20)**

(i) (a) Enumerate the role of stress triaxiality in formation of the cup and cone profile of fracture during tensile test of a ductile material.

(b) What is the limitation of tensile test in the context of fracture toughness?

(ii) (a) Explain the condition of singularity in the context of expressing the stress intensity at the tip of a crack.

(b) Explain the role of sample thickness in estimation of K_{IC}.

(iii) (a) Explain the role of particles and grain boundary in determining the stress for the brittle fracture.

(b) Establish the correlation of the J integral and CTOD with energy release rate at the crack tip.

4. Answer the followings (any THREE) : **(5×3=15)**

(a) Goodman diagram

(b) Five factors responsible for scatter in fatigue result

(c) Probability tree for initiation and propagation of cleavage

(d) Deformation mechanism map

(e) Diffusion creep

5. Answer of the following (any TWO): **(5×2 =10)**

(a) A plate of thickness 20mm contains a sharp crack of length 5mm. Given K_{IC} = 40 MPa($m^{1/2}$) and σ_Y = 500 MPa. Determine the Irwin correction, if applicable.

(b) Determine the largest flaw allowable for :

(i) a low strength steel with ΔK_{th} = 7 MPa($m^{1/2}$) and σ_Y = 300 MPa

(ii) a low strength steel with ΔK_{th} = 4MPa($m^{1/2}$) and σ_Y = 1500 MPa

The loading is cyclic with the stress range of 0.5 σ_Y. Value of the geometric constant for estimation of ΔK_{th} is 0.637.

(c) At a constant stress (50 MPa), the strain rates at T_1 (427°C) and T_2 (538°C) are $10^{-7}h^{-1}$ and $8\times10^{-6}h^{-1}$, respectively. Determine the activation energy.