23/11/13

B.E.(FULL-TIME) DEGREE END SEMESTER EXAMINATIONS, NOV/DEC 2013
MATERIALS SCIENCE AND ENGINEERING
SEVENTH SEMESTER - ELECTIVE
(REGULATIONS 2008)

19

ML 9042 – FRACTURE MECHANICS AND FAILURE ANALYSIS

Time: 3 Hours **Answer ALL Questions** Max. Marks: 100

PART – A (10 X 2 = 20 Marks)

1. Distinguish 'Modulus of resilience' and 'Modulus of toughness'.
2. Write down the strain compatibility equation.
3. What do you understand by linear elastic fracture mechanics?
4. Mention the energy release rate (G) for an incremental crack extension in the case of plain stress and plane strain condition.
5. State Von mises yield criteria.
6. Distinguish ductile and brittle fracture with respect to fracture toughness.
7. Write down the Goodman and Soderberg equation.
8. Distinguish LCF and HCF.
9. Mention the significance of stress ratio.
10. Sketch the variation of fracture toughness with respect to through thickness values.

PART – B (5 X 16 = 80 Marks)

11. A large plate containing a crack is subjected to a remote and uniform tensile load in the direction of y-axis and perpendicular to the crack line along the x-axis. What is the external stress that will cause instability?

12. (a) (i) Prove that $\sigma_t = \sigma_e (1+\epsilon_e)$ and $\epsilon_t = \ln(1+\epsilon_e)$ (6)

(ii) Explain how the Considere construction is useful in determining the nature of the material based on yield characteristics. (10)

(OR)

(b) (i) Derive the plane stress and plane strain conditions from Hooke's law. (10)

(ii) Obtain expression of Airy stress function in a compact form and mention its advantages. (6)

13. (a) Explain in detail Dugdale's plastic zone model for remote and plastic loading conditions.

(OR)

(b) Derive an expression for COD of a notional crack extending to center of plastic zone.

14. (a) Write a brief note on (i) Fatigue life with Variable stress amplitude (8)

(ii) Strain life approach on fatigue loading (8)

(OR)

(b) (i) Discuss the micro-mechanism involved in environment assisted fatigue failure. (8)

(ii) Explain how the overloading pulse retards the crack propagation rate. (8)

15. (a) An edge crack, detected on a large plate is of length 3.1 mm under a constant amplitude cyclic load having σ_{max} = 310 Mpa and σ_{min} = 172 Mpa. If the plate is made of ferrite pearlite steel and K_{IC} = 165 Mpa $\sqrt{m}$, determine (i) Propagation life upto failure and (ii) Propagation life if the crack length (**a**) is not allowed to exceed 25 mm (Take the material constants m=3 and c = 6.8 x 10^{-12} for ferrite pearlite steel.

(OR)

(b) Explain Irwin's leak-before criterion to predict the fracture toughness of pressure vessels.