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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER, 2017

Mechanical Engineering

(Machine Design)

01ME6110 Fracture Mechanics

Max. Marks : 60 Duration: 3 Hours

(Answer any two from each module)
Unless otherwise specified material properties may be assumed appropriately.

Part - A

1(a) Draw load –deflection curve of DCB specimen and obtain potential energy for each case
(i) a constant load
(ii) a constant displacement (3)

1(b) Explain one of the differences in the R- curve for brittle and ductile material? Give the two conditions for a crack to grow. (3)

1(c) Write down equations for the stress state corresponding to Mode III loading of an infinite plate . Draw the plastic zone shape (3)

2(a) Explain the behavior of semi elliptical crack growth in a pressure vessel (3)

2(b) What kind of singularity describes a stress field near the vicinity of a crack tip in LEFM? How differentiation of stress function is made possible. (3)

2(c) Explain the importance on the results of a collinear cracks in an infinite long strip (3)

3(a) How Westergaard's stress function for biaxial stress field is applicable for mode-I load case ? (3)

3(b) Determine the value of mode I SIF for the following cases
(a) Infinite plate with centre crack with 2a = 40 mm, thickness of the plate = 2mm and far field stress of 125MPa
(b) Infinite plate with edge crack with a = 20 mm, thickness of the plate = 2mm and far field stress of 125MPa
(c) Strip with edge crack under bending , a = 20mm , depth , W = 50 mm, thickness, B = 25 mm and bending moment, M = 1000 N-m , treat finite width correction factor as 1.09 (6)

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Part - B

4(a) Derive the approximate plastic zone size for mode-I plane stress and plane strain condition. Given principal stresses and local stresses at the crack tip are the same. (3)

4(b) What is the basis on which J integral approach is followed? (3)

4(c) What are the limitations in following S-N curve? (3)

5(a) Derive the relationship between CTOD and K_I. Note that crack opening v along load direction is given below (5)

$$v = \frac{1}{2\mu}\left\{\frac{2\sigma}{1+\nu}\left(a^2 - x^2\right)^{1/2}\right\}$$

where, μ is the modulus of rigidity, a is semi crack length and v is Poission's ratio and x =0 at the middle of the crack.

5(b) How fatigue crack initiates on a smooth surface? For a nucleation life of 10^4 cycles corresponding to a crack length for a crack length of 40 mm, the ratio of ΔK to square root of radius of curvature of crack root is measured as 1500MPa. If crack root radius is 2.5mm, what is the $(K_{max} - K_{min})$? (4)

6 (a) Write down the expression for SIF at minor and major axes of an elliptical crack (3)

6 (b) Explain the fracture surface formation under plane stress and plane strain for mode –I (3)

6 (c) Draw plastic zone shape under plane stress and plane strain for mode - I loading (3)

Part – C

7 (a) How using single end notch beam $CTOD_c$ is determined? (6)

7 (b) An infinite plate with a centre crack is subjected to a constant amplitude fatigue load with σ_{max} = 120MPa and σ_{min} = 12MPa. Calculate the life of the component if initial crack length is 2.6mm and K_{IC} = 90MPa. The Paris law constants are C=6.0 x10^{-12}MPa m^{-}12 and m=3. Arrive at the formula used. (6)

8 (a) The test configuration for K_{IC} gives conservative estimate. Justify the approach. (4)

8 (b) What is the condition for a crack arrest? Give three practical examples when crack arrest Occurs?. (4)

8 (c) Explain the behaviour of fatigue crack closure.What modification is required for Paris law? . (4)

9 (a) Draw a Chevron notch and write down its advantages of for K_{Ic} test? (4)

9 (b) Explain the behavior of multiple branch cracking during dynamic instability. (4)

9 (c) Bring out the significance of overload pulse on retarded crack growth. (4)

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