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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

February / March 2023 Semester End Main Examinations

Programme: B.E. **Semester: VII**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 20ME7DEFRM **Max Marks: 100**
Course: Fracture Mechanics **Date: 28.02.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may suitably be assumed.

UNIT - I

1 a) Determine Values of K_I in some cases for the following values **10**
   i) Circumferentially cracked round bar under tension; a=20mm, D=100mm, P=80kN.
   ii) Circumferentially cracked round bar in torsion: a=10mm, D=100mm, M_t=40kN-m.

b) Name the NDT methods for detecting internal cracks. Explain any two methods with the aid of sketches. **10**

OR

2 a) With a neat sketch show Chevron notch. Why Chevron notch is better than a V notch for Kc test specimen? Explain. **06**

b) What is side grooving? Explain its importance. **04**

c) Consider a material where K_{IC} =35MPa$\sqrt{m}$. Three test specimens have been fabricated from this material. The specimens are SENB, CCT and SECT. In each case B=25.4mm, W=50.8mm and a/w =0.5, estimate the failure load for each specimen. Which specimen has the highest failure load? Which has the lowest Failure load? **10**

UNIT - II

3 a) Apply Irwin's correction to determine the SIF, the length of the effective crack and the plastic zone size for edge crack of 15mm length in a plate 80 mm width. The Thickness of the plate is 5mm and the far-field stress is 150MPa (σ_{ys}=350MPa). **10**

b) Obtain the size of the plastic zone ahead of the crack tip according to Dugdale's approach. **10**

OR

4 a) Using Griffith's energy balance formulation show that **05**

$$\sigma = \sqrt{\frac{2E\gamma s}{\pi a}}$$

where E = Young's modulus, a = half crack length, γ_s = Surface energy of the material

b) Discuss with the help of neat sketch, strain energy release rate G and R curves for both brittle and ductile materials. **05**

c) Determine values of K_I for an oblique crack in a semi-infinite plate: a=30mm, β=45°, σ =200MPa. **05**

d) Determine the energy release rate for an edge cracked loaded as shown in the figure 4d. **05**

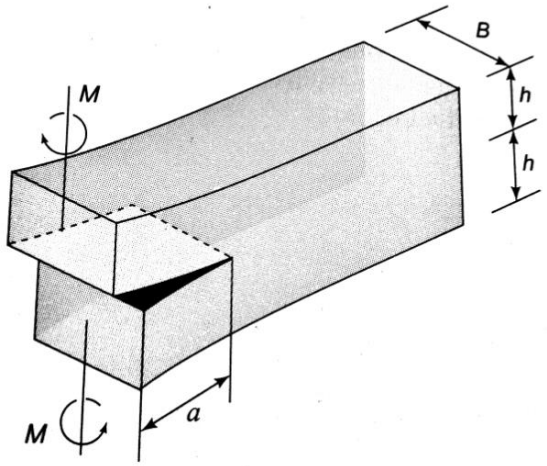

Figure 4d

UNIT - III

5 a) What is CTOD? With a neat sketch explain how to obtain CTOD if CMOD and rotational factor are known for a particular specimen configuration. **06**

b) Obtain equivalence between CTOD and J. **04**

c) Define the J integral. Show that J integral is path independent. **10**

UNIT - IV

6 a) A large plate contains a crack of length $2a_o$ and is subjected to a constant-amplitude tensile cyclic stress normal to the crack which varies between 100 MPa and 200 MPa. The following data were obtained: for $2a_o$ = 2 mm it was found that N = 20,000 cycles were required to grow the crack to $2a_f$ = 2.2 mm, while for $2a_o$ = 20 mm it was found that N = 1000 cycles were required to grow the crack to $2a_f$ = 22 mm. The critical stress intensity factor is K_{IC} = 60 MPa√m. Determine the constants in the Paris equation and Forman equations. **10**

b) State Fatigue crack closure mechanism in metals and explain them with neat sketches. **10**

UNIT - V

7 a) Explain practical crack arrest mechanism of decreasing energy release rate G, using a neat sketch. **05**

b) Explain with figure the phenomenon of crack branching considering the kinetic energy. **05**

c) Discuss Kinetic Energy and Crack speed after crack reaches critical crack length and also derive crack speed expression. **10**

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