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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Second Semester, M. Tech – Mechanical Engineering (MMDN)

Semester End Examination; June - 2016

Fracture Mechanics

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Assume suitable missing data if any.
iii) Use of data hand book is permitted.

UNIT - I

1 a. State the Griffith's Energy balance criterion. Derive an expression for the fracture strength of a brittle solid, containing through thickness elliptical crack. 10

b. What are ductile and brittle fractures? State their characteristics. 6

c. Briefly explain the historical development in fracture mechanics. 4

2 a. Define Fracture. Explain with neat sketch the modes of fracture failure. 8

b. Explain different NDT methods used in detecting the crack. 6

c. A flat plate with a through thickness crack is subjected to a 200 MPa tensile stress and has a fracture toughness K_{IC} of $50MPa\sqrt{m}$. Determine the critical crack length assuming the material linear elastic. Also calculate the energy release rate (G_c) of the material. 6

Assume E = 207000 MPa.

UNIT - II

3 a. Show that stress intensity factor for mode-I (K_I) for the single edge notched tensile panel reduces to ; $K_I = 1.12\sigma\sqrt{\pi a}$ for a << w. 8

b. Write an expression for the plastic zone size according to Irwin approach and draw the plastic zone shapes for all the three modes of plane stress and plain strain conditions. 8

c. Discuss the effect of thickness on the fracture toughness. 4

4 a. Describe the test procedure for determining I_{IC} using three points bent specimen in the laboratory. 10

b. Derive an expression for the relationship between 'G' and 'K_I'. 5

c. Explain the significance of R-Curve. 5

UNIT - III

5a. Determine the energy release rate for a DCB specimen. Also obtain an expression for K_I. 8

b. Define J-integral. Show that the J-integral is path independent and explain the terms in J-integral expression. Mention its properties. 12

Contd…2

6 a. Using Paris formulation for fatigue crack growth, obtain an expression for the number of cycles, required for the crank to propagate, for an initial length 'a_i' to a final length 'a_f' for the case if m = 2. 12

b. Explain the factors influencing the fatigue crack growth. 8

UNIT - IV

7 a. Explain the basic principles of crack arresting methods. With neat sketches, explain at least three such techniques. 10

b. Explain the concept of leak before break criterion. 10

8 a. Write short notes on :

(i) Importance of K-R curve in fracture analysis, 10

(ii) Damage tolerance design.

b. Derive the equation for the crack-propagation speed. 10

UNIT - V

9 a. Explain the factors affecting the crack propagation. 10

b. List the fatigue crack growth laws and explain any three laws with formulae. 10

10 a. Write a note on :

(i) Effect of overload on the fatigue crack growth, 10

(ii) Computational fracture mechanics.

b. Explain strain energy density criterion. 10

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