

## Design methodology for fracture, fatigue and creep

Time : 3 hrs

B.E. MECHANICAL ENGINEERING -FOURTH YEAR  
FIRST SEMESTER EXAM 2019

full Marks : 100

## CO-1

1. Answer any four questions : (4X4=16)

- Discuss the role of fracture mechanics in Design.
- Discuss the design principle based on CTOD following PD-6493.
- Explain effect of stress-triaxiality on fracture toughness.
- Describe stable and unstable crack growth.
- Show that  $G$  is same for load control is and displacement control.

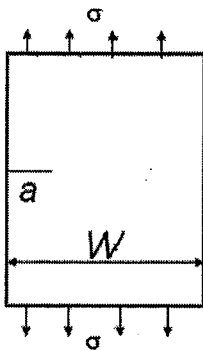
## CO-2

- Discuss the principle and method of computing J integral by EPRI method.
  - How J-R curve is measured experimentally?
  - A 3 mm thick tension panel 10 cm wide containing an edge crack of 1 mm yielded at a load of 150 kN. However, at a load of 120kN, another panel of same material cracked into two pieces when the crack was 5 mm long. With this information, calculate the yield stress and fracture toughness of the material.

## CO-3

7 + 6 +4

- Explain FAD at different levels and its application in design.
  - How FAD is modified for application for design of welded parts ?
  - containing an edge crack of 20 mm and determine the plastic zone size and effective crack length and effective stress intensity factor. The plate is loaded in Mode I with a far field stress of 150MPa and the yield strength of the material is 350MPa. The stress intensity factor (SIF) is indicated in the sketch.



$$K_I = \sigma \sqrt{\pi a} f(\alpha) ; \alpha = a/W ; 0 < \alpha < 0.6$$

$$f(\alpha) = 1.12 - 0.23 \alpha + 10.55 \alpha^2 - 21.72 \alpha^3 + 30.39 \alpha^4$$

## CO-4

8 + 4 + 5

4. Answer any three questions (3X6 =18)

- Compare failure mechanism due to fatigue and fracture .
- Discuss S-N curve and application in design considering effect of mean stress on it.
- Derive the equation for fatigue crack growth curve considering all the features ?
- Discuss the in detail the principles of strain – life equation for LCF, HCF combined?
- Discuss the factors influencing endurance strength.

[ Turn over

**CO-5**

5. a) Discuss S-N curve and application in design considering effect of mean stress on it.

b) An un-notched component is subjected to four level step-stress fatigue test, which starts with the stress level  $\pm 1000$  MPa to  $\pm 100$  MPa. At each stress level a cycle fraction of 0.01 is added before proceeding to next level. The sequence 1,2,3,4 is repeated until failure occurs at damage,  $D = 1.0$ . Four step stress level ( $S_i$ ), applied cycles ( $n_i$ ) and associated fatigue life cycles ( $N_i$ ) are listed in table.1. Estimate the fatigue life based on the non linear damage rule or Bi linear Damage rule given by Manson & Halford.

**Table 1.**

Sl.no	Stress level (MPa)	Applied cycle (n)	Fatigue life (N)
1	$\pm 800$	10	1000
2	$\pm 600$	100	10000
3	$\pm 400$	1000	100000
4	$\pm 200$	10000	1000000

7 + 9

**CO-6**

6. Answer any four questions (4X4 =16)

- Draw and discuss the aspects of a creep curve.
- Derive the creep equation given by Andrade and also by Garafallo.
- How creep fatigue interaction can be modelled.
- Explain how creep test data are presented.
- Explain the reason behind creep behaviour.