Ref No : PG/ME/T/129G/2024

M.E. MECHANICAL ENGINEERING FIRST YEAR SECOND SEMESTER – 2024

Department of Mechanical Engineering

Sub : Design for Fracture, Fatigue and Creep

Full Marks : 100 **time : 3 hrs**

Answer any five questions (20X5 = 100)

1. a) Derive and compare failure stress from atomic theory, stress concentration and Griffith's crack growth theory
   b) Prove that the value of K_I is same in load control and displacement control.
   c) Explain **plain strain fracture toughness** and why it is used in design ?

   8+6+6

2. a) Describe the method of determination of J Integral using EPRI method.
   b) Explain the design rule for stable and unstable crack growth using J-$\dot{R}$ Curve.
   c) Explain the concept of leak before break design principle.

   7+6+7

3. a) Why J-R curve cannot be used as material property ?
   b) Explain the design principle followed by PD 6493 using CTOD as fracture parameter.
   c) Explain the condition for crack initiation, stable crack growth and unstable crack growth in reference to J-R curve .

   6+7+7

4. a) Explain different options for Failure Assessment Diagram (FAD).
   b) How creep curve depends on stress and temperature.
   c) Explain Creep test and creep rupture test.

   10+5+5

5. a) Derive a common design equation applicable for both LCF anf HCF.
   b) Explain Haigh diagram.
   c) Explain the different factors influencing endurance strength.

   8+5+7

6. a) The fatigue strength vs cycle data of a material is given in table 1. Two cases of operating load vs no of cycles of a member made of this material is given in table 2. Find out the residual lifes for both the cases the non-linear cumulative damage rule by Manson and Halford if the third load is of stress amplitude of 300 MPa.

Table .1

Sl . No	Stress amplitude (Mpa)	Cycles to failure
1	400	100
2	300	1000
3	200	4000
4	100	6000
5		

[Turn over

Table 2

Sl.No	Stress amplitude	No of cycles operated
Case1		
1	400	50
2	200	1000
Case 2		
1	200	1000
2	400	50

b) A mild steel plate is subjected to constant amplitude fatigue load varying from 200 Mpa to 20 MpaThe static properties of the steel are as : σ_0 = 480 MPa, σ_u = 600 MPa, E + 205 GPa, K_C = 120 MPa-$m^{0.5}$ .The plate contains an initial crack of 1mmHow many fatigue cycles will be required to break the plate. Assume Paris' Constants for the steel as , C= 6.9 X 10^{-12} MPa-$m^{0.5}$ and m = 3. Form factor for this edge crack, α = 1.2

10 +10

7. a) Explain logarithmic creep and viscous creep.
   b) Explain different creep mechanism.
   c) For the following creep rupture data, construct a Larson-Miller plot (assuming C = 20). Determine the expected life for a sample tested at 650°C with a stress of 240MPa, and at 870°C with a stress of 35MPa. Compare these values with actual test results of 32,000 and 9000 hr, respectively.

Temperature (^{0}C))	Stress (MPa)	Rupture time (hr)	Temperature (^{0}C))	Stress (MPa)	Rupture time (hr)
650	480	22	815	140	29
650	480	40	815	140	45
650	480	65	815	140	65
650	450	75	815	120	90
650	380	210	815	120	115
650	345	2700	815	105	260
650	310	3500	815	105	360
705	310	275	815	105	1000
705	310	190	815	105	700
705	240	960	815	85	2500
705	205	2050	870	8337	

5+5+10