Ref. No.: Ex/Met/PC/H/T/426/2024

B.E. METALLURGICAL ENGINEERING FOURTH YEAR

SECOND SEMESTER EXAM 2024

SUBJECT: CREEP & FRACTURE MECHANICS OF MATERIALS (HONS.)

Time: Three hours **Full marks: 100**

(Answer Question No. 1 and any three from the rest)

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1. Answer any eight from the following: 5x8 = 40

a) Whether creep deformation can occur at ambient temperature? How would you express the creep strength of a material? **[CO1]**

b) Why is the extrapolation of short-time creep rupture data to long times at the same temperature is extremely dangerous? Discuss. **[CO2]**

c) Between single crystal and polycrystal which one would offer better creep resistance property and why? **[CO2]**

d) What is 'residual strength diagram?' – discuss. **[CO3]**

e) How does fracture toughness of a material depend on temperature? Give reason in support of your answer. **[CO3**

f) What is the need for studying 'fracture mechanics?' **[CO4]**

g) What is the difference between 'stress concentration factor' and 'stress intensity factor?' **[CO4]**

h) Why is K_{IC} known as a material property? What condition needs to be satisfied for K_{IC} to be a material property? **[CO4]**

i) Justify whether the value of the K_{IC} will vary in presence of a corrosive medium as compared to that in neutral environment? **[CO5]**

j) What is known as K_{ISCC}? How does K_{ISCC} differ from K_{IC}? **[CO5]**

k) How will you determine K_{ISCC} ? **[CO5]**

2. (a) How would you determine the 'activation energy' for creep deformation? **[CO1]** 5

(b) What is 'Dorn' parameter? Find the LMP by using the 'Dorn' parameter. What is the utility of LMP? **[CO2]** 2 + 5 + 3 = 10

(c) Write a short note on '**equicohesive temperature**.' **[CO2]** 5

3. (a) After deriving all the necessary steps find the equivalence in fracture stress obtained considering stress concentration point of view and that based on Griffith's criterion. **[CO3]** 15

(b) Between Gray Cast Iron and Nodular Cast Iron which is more brittle and why? **[CO3]** 5

4. (a) What is known as 'strain energy release rate?' What is its unit? **[CO4]** 5

(b) Derive the relationship used for expressing 'strain energy release rate' under constant displacement loading condition. **[CO4]** 10

(c) How can this energy release rate be used as a material property for fracture? Discuss. **[CO4]** 5

[Turn over

5. (a) What is known as 'R' curve? How is the R curve determined? **[CO4]** 2+8=10

(b) Justify the nature of 'R' curve. **[CO4]** 5

(c) Assume that a component in the form of a large sheet is to be fabricated from 0.5-Ni-Cr-Mo steel. It is required that the critical flaw size be greater than 3 mm, the resolution limit of available flaw detection procedures. A design strength of one-half the tensile strength is indicated. To save weight an increase in the tensile strength from 1520 to 2070 MPa is indicated. Is such a strength increment allowable? (Assume plane strain condition in all computations.) **[CO4]** 5

Given: K_{IC} = 66 MPa $m^{1/2}$ at 1520 MPa and 33 MPa $m^{1/2}$ at 2070 MPa.

6. (a) State the law for 'fatigue crack growth rate' and present the law by schematic graph. How would you interpret this schematic graph? **[CO4]** 3+ 3 + 4 = 10

(b) Discuss the concept of J – integral. Show that this integral is related with potential energy difference? **[CO4]** 4 + 6 = 10