Ex/ME/5/T/413B/2024(S)

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) FOURTH YEAR FIRST SEMESTER SUPPLEMENTARY EXAM 2024

DESIGN METHODOLOGY FOR FRACTURE FATIGUE AND CREEP

Time: **Three hours** Full Marks: **100**

Missing data, if any, are to be reasonably chosen.

Answer any Four (04) questions

1. a) How the S-N curve is obtained. b) Discuss the S-N diagram for ferrous and non-ferrous materials. c) A solid circular shaft is subjected to torsional moment that varies from 100 N-m to 300 N-m and at the same time, is subjected to bending moment that varies from 100 N-m to 200 N-m. The frequency of variation of these stresses is equal to the shaft speed. The shaft is made of plain carbon steel (σ_y =400 N/mm^2 & σ_{ut} = 540 N/mm^2) and the corrected endurance limit of the shaft is 220 N/mm^2. Determine the shaft diameter considering a factor of safety of 1.5. 06+06+13

2. a) What is fracture? b) How do we classify fracture? c) Derive the expressions of failure stress from atomic point of view, based on stress concentration and Griffith energy release rate. d) What is $\mathcal{G}$ and prove that it is equal in load controlled and displacement controlled conditions. e) How plane strain fracture toughness is determined?
01+02+12+06+04

3. a) Draw the creep curve for constant load and constant stress. b) Explain the following: transient creep, steady state creep and tertiary creep. c) Discuss Andrade's and Garofalo's equations. d) Name the factors which influence the creep of a material. e) What is creep fatigue interaction? f) Define rupture strength and creep strength.
04+06+04+02+05+04

4. a) Discuss the design procedure when mean stress of the loading is zero in fatigue. b) If now, the mean stress and amplitude stress are non-zero, what should be design procedure? c) What is cumulative damage in fatigue? d) A bar made of steel 45C8 (S_{ut} = 630 N/mm^2) is subjected to a completely reversed axial stress. The load factor= 0.85, surface finish factor=0.75, reliability factor=0.702, size factor=0.75, theoretical stress concentration factor=2.5, notch sensitivity factor=0.7. Calculate the fatigue strength of the bar for a life of 90,000 cycles.
04+05+04+12

5. Write short notes on:
   a) Stress concentration factor, b) Modified Goodman line c) Notch sensitivity factor, d) Factors affecting endurance limit e) Determination of S-N curve for non-zero mean stress 05x05