BACHELOR OF ENGINEERING (MECHANICAL ENGG.) FOURTH YEAR FIRST SEMESTER 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 Five (05) questions

1. a) Explain S-N diagram. b) What is modified endurance limit and why the modification is required? c) A solid circular shaft is subjected to torsional moment that varies from 180 N-m to 400 N-m and at the same time, is subjected to bending moment that varies from 70 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/mm² & σ_{ut} = 540 N/mm²) and the corrected endurance limit of the shaft is 200 N/mm². Determine the shaft diameter considering a factor of safety of 1.5.   *04+04+12*

2. a) What is theoretical stress concentration factor? b) With some examples, discuss the procedures to minimize the effects of stress concentration. c) Derive the expression of failure stress from the concept of atomic theory and why it fails to explain the failure of a component having crack. d) Explain Griffith's condition for crack growth and derive the expression for energy release rate for an infinite plate having a central crack of length "2a".   *03+03+08+06*

3. a) What is $\mathscr{G}$ and prove that it is equal in load controlled and displacement controlled conditions? b) What is stress intensity factor? Write down the expression of the same with unit. c) How fracture toughness depends on the thickness of the specimen? d) Explain the procedure for determination of fracture toughness?   *08+05+03+04*

4. a) Explain creep curve. b) Discuss Andrade's and Garofalo's equations. c) Name the factors which influence the creep of a material. d) What is creep fatigue interaction? e) Define rupture strength and creep strength.
     06+04+02+04+04

5. a) What is cumulative damage in fatigue? b) A machine part is operated for a time of 4.8 hours at σ_1 stress level. The load is removed and the part is operated at a stress level of σ_2 for a time of 7.2 hours when the failure occurs. If the life of the component at σ_2 stress level alone is 7.5 hours, calculate the life of the component at σ_1 stress level alone. Frequencies of applied periodic loads remain same for both the cases. c) What is the procedure to develop the S-N curve in design for non-zero mean stress? d) A rotating bar made of steel 45C8 (S_{ut} = 630 N/mm²) is subjected to a completely reversed bending stress. The corrected endurance limit of the bar is 315 N/mm². Calculate the fatigue strength of the bar for a life of 90,000 cycles.   *04+04+04+08*

6. Write short notes on:
   a) Fatigue stress concentration factor, b) Notch sensitivity factor, c) Soderberg and Goodman line, d) von-Mises theory of failure
                                                                                                      04x05