B.E. MECHANICAL ENGINEERING SECOND YEAR SECOND SEMESTER EXAM 2022

Subject: Design of Machine Elements I **Time: Three Hours** **Full Marks: 100**

Missing data, if any, are to be reasonably chosen.
Give sketches wherever applicable.
Answer any **Four (04)** questions

1. a) What is factor of safety and what are the factors influencing factor of safety ? b) Discuss in detail the considerations of manufacturing aspects in design. c) Discuss the fundamental design considerations. d) Discuss the points to be considered for selection of material. e) Discuss the hardness of material and its measurement. *05x05*

2. a) Design and draw a cotter joint based on rational design taking suitable material with proper justifications. b) How do the tensile properties vary with temperature and percentage of carbon? *(20+05)*

3. a) What is the importance of failure theories in design? b) Derive expression of equivalent stress from Rankine's, von-Mises, Coulomb, St. Venant's, and Haigh's theories of failure. c) Explain one failure theory for brittle material with unequal strength in tension and compression. d) An element is loaded by stresses σ_x= 150 MPa, σ_y= 15 MPa, and τ_{xy}= 50 MPa. Material is cast iron with σ_{ut}= 260 MPa and σ_{uc}= 850 MPa. Will the part fail if the factor of safety is 1.5?
(02+10+05+08)

4. a) Explain the significance of fracture mechanics in design. b) What is fracture toughness? c) Describe creep curve and its significance. d) How the shafts are designed based on strength and rigidity? e) Design a shaft based on ASME code using the following data: Toque and bending moments applied are 550 N-m and 200 N-m respectively. ii) The load is applied with light shock. iii) The shaft material is steel having ultimate strength 530 N/mm^2, yield strength of 320 N/mm^2. The shaft has a keyway. *(03+02+05+05+10)*

5. a) Explain S-N curve and its applications in design for non-zero mean stress. b) Discuss the factors that affect the endurance limit. c) A solid circular shaft made of steel (tensile strength= 620 MPa, yield stress= 380 MPa) is subjected to an alternating torsional moment which varies from -310 N-m to +600 N-m and at the same time shaft is subjected to a bending moment that varies from +150 N-m to +400 N-m. Calculate the shaft diameter using Gerber, Goodman and Soderberg lines. The corrected endurance limit and factor of safety values are 210 MPa and 2.5 respectively.
(05+05+15)

6. a) Discuss the design principles for short and long columns. b) What is fatigue stress concentration factor and how the fatigue stress concentration factor may be estimated from theoretical stress concentration factor? c) Derive the strain life equation applicable to low cycle and high cycle fatigue both. d) A machine component made of steel is subjected to a reversed bending stress of 340 MPa for 20% of the time, a reversed bending stress of 470 MPa for 40% of the time, and a reversed bending stress of 570 MPa for 40% of the time. Determine the expected life of the component using the following: σ_{yt} =500 N/mm^2, σ_{ut} = 700 N/mm^2, corrected endurance limit: 250 MPa. *(06+05+06+08)*