Ex/ME/T/225/2017

BACHELOR OF MECHANICAL ENGINEERING EXAMINATION, 2017

(2^{nd} Year, 2^{nd} Semester)

Subject: MACHINE DESIGN -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) Develop an NLP for optimum design of any mechanical system. b) Discuss in detail the considerations of manufacturing aspects in design. c) Discuss the significance of fits and tolerance in design. d) Discuss the ASME principles for the design of a shaft. e) Discuss different types of hardness and their measurements.

(06+05+05+04+05)

2. a) Design a cotter joint based on rational design. b) Discuss different heat treatment processes for improving material properties. c) Discuss the designation procedures of different steels. d) Discuss the role of different alloying elements to improve material properties. *(12+05+04+04)*

3. a) Compare Rankine, von-Mises and Tresca failure theories. b) Explain one failure theory for brittle material with unequal strength in tension and compression. c) Explain the role of stress concentration factor and notch sensitivity in design. d) A solid circular shaft made of steel (tensile strength= 600 MPa, yield stress= 370 MPa) is subjected to an alternating torsional moment which varies from -300 N-m to +600 N-m and at the same time shaft is subjected to a bending moment that varies from +100 N-m to +400 N-m. Calculate the shaft diameter using the following data: corrected endurance limit=210 MPa, Factor of safety=2.5. *(06+03+04+12)*

4. a) Explain the significance of fracture mechanics in design. b) What is $\mathcal{G}$ and prove that it is equal in load controlled and displacement controlled conditions. c) What is stress intensity factor? d) How plane strain fracture toughness is determined? e) Explain the condition for stable and unstable crack growth. f) Calculate the factor of safety based on the following data: maximum allowable crack length = 1.2 mm, σ_{yp} =510 N/mm^2, K_{IC}= 10 MPa$\sqrt{m}$ and loaded to a stress of 300 MPa. *(03+05+03+05+04+05)*

5. a) Explain S-N curve and its applications in design for non-zero mean stress. b) Derive the strain life equation applicable to low cycle and high cycle fatigue both. c) A machine component made of steel is subjected to a reversed bending stress of 280 MPa for 25% of the time, a reversed bending stress of 350 MPa for 35% of the time, and a reversed bending stress of 450 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: 240 MPa. *(07+08+10)*

6. a) Discuss the design principles of column considering stability. b) Explain the creep curve and its significance. c) Discuss Andrade's and Garofalo's equations. d) How creep test data is presented? e) Discuss the principles of creep fatigue interaction. *(06+04+05+04+06)*