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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec - 2019

Design of Machine Elements - I

Time: 3 hrs Max. Marks: 100

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Missing data, if any, may be suitably assumed. iii) Use of design data hand book is permitted.

UNIT - I

1 a. Briefly explain the design criteria based on, i) Strength ii) Rigidity. 4

b. With necessary sketch explain;
i) Modulus of toughness ii) Percentage elongation to failure iii) True stress at failure. 6

c. Two rods subjected to tensile force of 50 kN are connected by means of a cotter joint. The outside diameter of the socket collar is 100 mm. Determine the width and thickness of the cotter made of SAE 1025 annealed based on shearing and bending strength.
Assume a FOS of 4. 10

2 a. Define stress concentration and write the expression for stress concentration factor. 3

b. A flat plate 50 mm wide has a central hole 10 mm in dia. If the plate is subjected to tensile load, determine the stress concentration factor, sketching the plate geometry. 3

c. A shaft shown in Fig. Q2(c) is subject to axial, bending and torsional load. Determine;
i) Maximum principal stress ii) Maximum shear stress
iii) Von mixes stress at points A and B 14

UNIT - II

3 a. Write two distinct features of low cycle fatigue and high cycle fatigue. 4

b. Obtain stress-life equation for SAE 1025 annealed steel. 6

c. In a cam-follower system, the follower of mass 5 kg drops suddenly on the cam from a height of 2 mm. If the cam is at midway of a shaft 400 mm long between the bearings, determine the maximum stress induced in the shaft and the corresponding shaft deflection, the diameter of the shaft is 10 mm and the elastic modulus of shaft material is 200 GPa. 10

4 a. Define stress concentration and notch sensitivity of a material. Write equations for fatigue stress concentration factor and notch sensitivity factor. 4

b. The shaft shown in Fig. Q 4(b) is subjected to variable bending and torsional moment as indicated in the figure. Determine the dimensions of the shaft considering cast steel, soft as the material. Assume the size correction factor as 0.8, notch sensitivity index as 0.5 and factor of safety as 2. Design the shaft based on equivalent maximum shear stress. The shaft is fabricated by hot rolling. 16

Contd…2

UNIT - III

5 a. A shaft is driven by means of a motor placed vertically below it as shown in Fig. Q 5(a). The diameter of the pulley is 1.5 m and the belt tensions are 5.4 kN and 1.8 kN respectively on tight and slack sides. Determine the diameter of the shaft if the load is applied gradually and the shaft material is 45C8 steel, with a FOS of 4. Design based on maximum shear stress. 8

b. Design a CI flange coupling to transmit 18 kW at 1440 rpm. The allowable stresses for shafts, keys and bolts are 75 MPa in shear and 150 MPa in crushing, the allowable shear stress for CI flange is 5 MPa. 12

6. A shaft is supported by two bearings 1 m apart. A 600 mm dia pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of a belt having maximum tension of 2.25 kN. Another pulley 400 mm in diameter is placed 200 mm to the left of right hand bearing and is driven by an electric motor which is horizontally in front of it. The angle of contact for both the pulleys is 180° and coefficient of friction is 0.24. Determine suitable diameter of the solid shaft with allowable working stress of 63 MPa in tension and 42 MPa in shear. Assume combined shock and fatigue load factors of 2.0 in bending and 1.5 in torsion. 20

UNIT - IV

7 a. Derive the expression for final bolt load, considering the effects of initial bolt load and stiffness of bolts and gaskets, showing the load-deformation diagram. 8

b. A vertical two start square threaded screw of 100 mm mean diameter and 20 mm pitch supports a vertical load of 18 kN. The axial thrust on the screw is taken by a collar of 250 mm outside dia and 100 mm inside dia. Find the force required at the end of 400 mm long lever in order to lift and lower the load. The coefficient of friction is 0.15 for the screw and 0.2 for the collar. 12

8 a. The bracket shown in Fig. Q. 8 (a) is bolted using M 20 bolts. Determine the maximum load that can be applied to the bracket, if the allowable tensile stress in the bolt material is 90 MPa. 10

b. A power screw with single start thread of 6 mm pitch and 40 mm nominal diameter is subjected to an axial load of 6 kN and a torque of 40 N-m. The nut length is 12 mm. Determine; 10

i) Maximum normal stress in the screw rod ii) Maximum shear stress in the screw rod

iii) Shear stress in the screw thread iv) Bearing stress in the screw thread

UNIT - V

9 a. Design a double riveted zig-zag butt joint with equal cover plates to connect two plates 20 mm thick. Calculate the efficiency of the joint. Take allowable stresses in tension, crushing and shear as 100 MPa, 120 MPa and 60 MPa respectively. 10

b. A bracket shown in Fig. Q 9 (b) carries a load of 10 kN. Determine the size of the weld, if the allowable shear stress is not to exceed 80 MPa. 10

Contd...3

10 a. Design the longitudinal seam joint of a stream drum whose inner diameter is 1680 mm and steam pressure is 2.1 MPa. The joint is triple riveted butt joint with an efficiency of 85% where the pitch of outer row is double that of inner rows and the width of cover plates are unequal. The ultimate tensile, crushing and shear stresses are 470 MPa, 780 MPa and 390 MPa respectively. Adopt a factor of safety of 5. 14

b. For the welded joint shown in Fig. Q.10 (b), determine the weld lengths, if the allowable shear stress is 120 MPa. 6

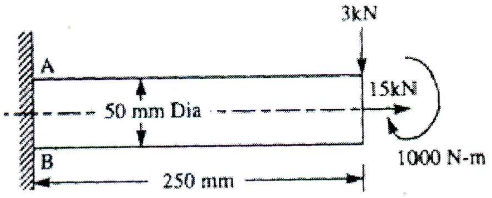

Fig.Q2(c)

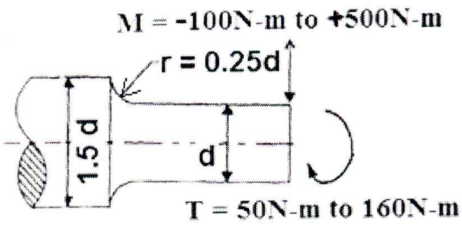

Fig.Q4(b)

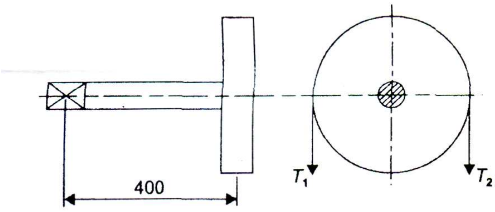

Fig.Q5(a)

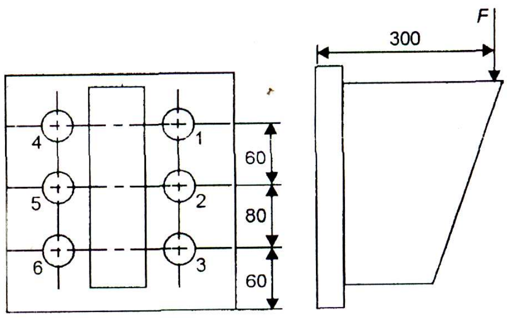

Fig.Q8(a)

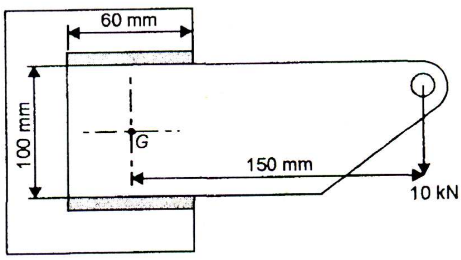

Fig.Q9(b)

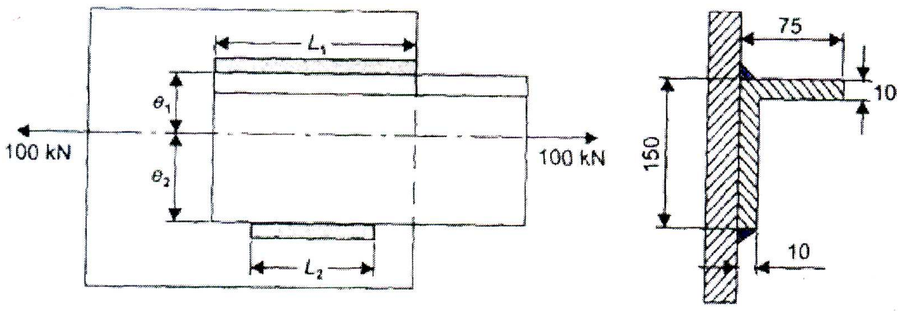

Fig.Q10(b)

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