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

(An Autonomous Institution affiliated to VTU, Belgaum)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec. - 2015

Design of Machine Elements - I

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer any **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Assume suitably missing data if required.
iii) Use of Design data hand book is permitted.

UNIT - I

1 a. Define factor of safety. 2

b. Discuss any four criteria for selection of factor of safety. 8

c. Determine the principal stresses and maximum shear stress at points 'A' and 'B' in the member shown in Fig. Q1(c). 10

2. Design a knuckle joint to transmit a load of 150 kN. The design stresses may be taken as 75 MPa in tension, 60 MPa in shear and 150 MPa in compression. Draw a proportionate sketch showing dimensions. 20

UNIT - II

3 a. Write the statement and the final design equation of,
(i) Maximum normal stress theory
(ii) Maximum shear stress theory
(iii) Distortion energy theory. Also show the design space for each theory of failure. 12

b. The flat bar shown in Fig. Q3 (b) is subjected to axial pull of 500 kN. Assuming that the stress in the bar is limited to 200 N/mm^2. Determine the thickness of the bar. 8

4 a. Derive Goodman design equation. Showing all the correction factors. 8

b. A shaft of 50 mm dia is joined with another shaft of 75 mm dia, with a fillet radius of 12.5 mm. The shaft material has an ultimate tensile strength of 200 N/mm^2, and an yield strength of 160 N/mm^2. If the shaft is subjected to completely reversed torsional load, What is the maximum torque that can be applied to the shaft, based on: 12
(i) Equivalent maximum normal stress
(ii) Equivalent maximum shear stress.
Assume A = 0.75, B = 0.85, C = 1.0, q = 1 and FoS = 2.

5. A Uniform circular mild steel shaft is mounted on two bearings 850 mm apart. The shaft carries a gear 'A' at 200 mm to the right of left hand bearing and a 200 mm dia pulley 'B' at 250 mm to the left of right hand bearing. The gear is subjected to a horizontal load of 3500 N and a vertical upward load of 9600 N. The pulley is driven by a horizontal belt drive with tension on tight side to be 6000 N and on slack side to be 2000 N. (Horizontal loads due to gear and belt act in same direction). 20

Contd…2

Determine the diameter of the shaft assuming allowable shear stress of 42 N/mm^2, C_m = 2, and C_t = 1.5. Take the weight of the pulley as 1500 N.

6 a. A cantilever beam of rectangular section has a length of 300 mm, width of 8 mm and depth of 10 mm. Determine the maximum bending stress in the beam, when a load of 40 N is dropped on the free end of the beam, through a height of 5 mm. 8

b. A steel spindle transmits 4 kW at 800 rpm. The angular deflection should not exceed 0.25º per meter of the spindle. If the modulus of rigidity of the spindle is 84x10^3 MPa. Find the diameter of the spindle and shear stress induced in it. 6

c. A pulley is mounted on a steel shaft as shown is Fig. Q6(c). If the belt tensions are 5400 N and 1800 N, find the diameter of the shaft, if the transverse deflection of the shaft is limited to 0.5 mm. Also determine the maximum bending stress induced in the shaft. 6

UNIT - IV

7 a. Derive the expression for bolt load in a bolted joint, considering the effect of pre-load. 8

b. Discuss about the bolted joints with soft gasket and hard gasket and obtain the expressions for bolt load in each case. 4

c. A machine vice shown in Fig. Q7 (c) has single start, square threads with 22 mm nominal diameter and 5 mm pitch. The outer and inner diameter of the friction collar are 55 mm and 45mm respectively. The coefficients of friction for thread and collar are 0.15 and 0.17 respectively. If a force of 125 N is exerted at the end of 150 mm long handle, calculate; 8

(i) the clamping force developed between the jaws

(ii) the overall efficiency of the clamp.

8 a. Two circular plates with outer dia (2d) and inner dia (d) are clamped together by means of a bolt as shown in Fig. Q8(a). The bolt is made of plain carbon steel with yield strength of 380 N/mm^2 and young's modulus of 207000 N/mm^2, while the plates are made of aluminium with young's modulus of 71000 N/mm^2. If the initial preload in the bolt is 5 kN and the external force acting on the bolted joint is 10 kN, determine the size of the bolt, considering a factor of safety of 2.5 8

b. Discuss about self-locking of power screws. 4

c. A power screw having double start square threads of 25 mm nominal diameter and 5mm pitch is acted upon by an axial load of 10 kN. The outer and inner diameter of the screw collar are 50 mm and 20 mm respectively. Assuming uniform wear condition at the collar and allowable bearing pressure of the screw as 5.8 N/mm^2. Determine; 8

(i) Torque required to rotate the screw

(ii) Normal and shear stresses in the screw rod

(iii) Number of threads in engagement with the screw.

Contd…3

UNIT - V

9 a. Design a double riveted butt joint with two cover plates for the longitudinal joint of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume joint efficiency as 75%; allowable tensile stress in the plate is 90 MPa; allowable compressive stress and shear stress of the rivet are 140 MPa and 56 MPa respectively. 12

b. Determine the length of the weld for a plate of size 120 mm wide and 15 mm thick to be welded to another plate by means of double parallel fillet and single transverse weld. Assume tensile and shear design strengths as 46 MPa and 20 MPa respectively. 8

10 a. A double riveted double cover butt joint in plates 20 mm thick is made with 25 mm diameter rivets at 100 mm pitch. The permissible stresses are 120 MPa in tension. 100 MPa in shear and 150 MPa in compression. Find the efficiency of the joint assuming strength of the rivet in double shear as twice that of single shear. 10

b. A welded connection shown in Fig. Q 10(b) is subjected to an eccentric load of 7.5 kN. Determine the size of the welds if the permissible shear stress for the weld is 100 N/mm^2. 10

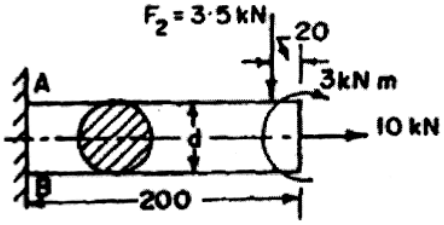

Fig.Q.1(c)

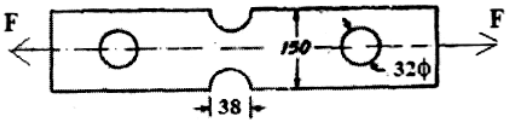

Fig.Q.3(b)

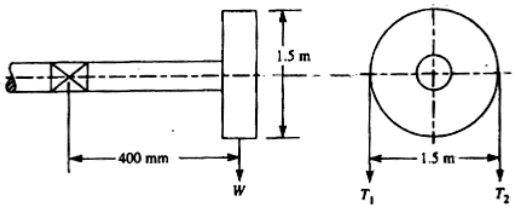

Fig.Q.6(c)

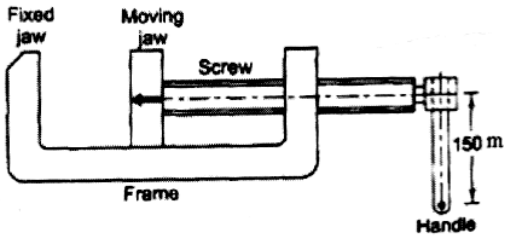

Fig.Q.7(c)

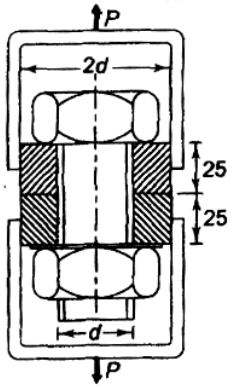

Fig.Q.8(a)

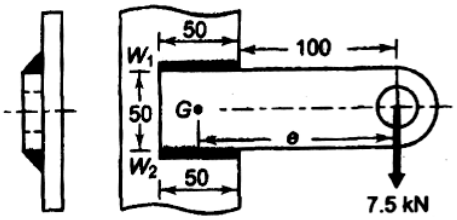

Fig.Q.10(b)

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