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10ME52

Fifth Semester B.E. Degree Examination, June/July 2023
Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of Design Data hand book is permitted.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Briefly discuss factors influencing the selection of suitable material for machine element. **(04 Marks)**

b. A point in a structural member is subjected to plane stress as shown in Fig. Q1 (b). Determine
(i) Normal and tangential stress on a plane inclined at 30° to vertical.
(ii) Principal stresses and direction.
(iii) Maximum shear stress and direction. **(10 Marks)**

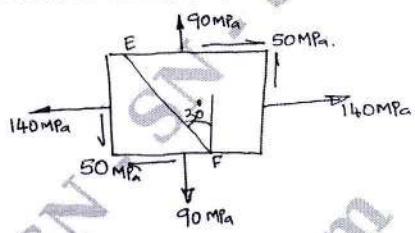

Fig. Q1 (b)

c. Determine the required thickness of the steel bracket at section A – A when loaded as shown in Fig. Q1 (c), in order to limit a tensile stress of 100 N/mm^2.

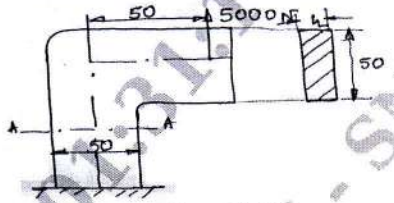

Fig. Q1 (c) **(06 Marks)**

2 a. A rod of circular cross section is to sustain a torsional moment of 300 kN-m and a bending moment of 200 kN-m. Selecting C45 steel having $\sigma_{yield} = 353$ MPa and assuming factor of safety = 3, determine the diameter of rod using,
(i) Maximum normal stress theory.
(ii) Maximum shear stress theory.
(iii) Distortion energy theory. **(06 Marks)**

b. A flat-plate subjected to a tensile force of 5 kN is shown in Fig. Q2 (b). The plate material is having a ultimate strength $\sigma_U = 200$ MPa. Determine the thickness of plate, take factor of safety as 2.5. **(06 Marks)**

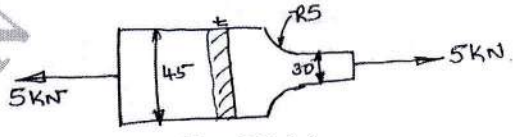

Fig. Q2 (b)

c. A power hammer weighing 4 KN strikes the mid point of a beam simply supported at its ends 4 mts apart. The beam has a depth of 200 mm and width 100 mm. Determine the height 'h' through which the hammer weight can be allowed to fall if the maximum stress in the beam is limited to 120 MPa. Take E = 206.8 GPa. **(08 Marks)**

3 a. Derive the Goodman's relationship. **(05 Marks)**

b. A hot rolled shaft is subjected to a torsional load that varies from 330 Nm clockwise and 110 Nm counter clockwise as an applied bending moment at the critical section varies from 440 Nm to -220 Nm. The shaft is of uniform cross section and no keyway is present. Determine the required shaft diameter. The material has an ultimate strength of 550 MPa and yield strength of 410 MPa. Factor of safety = 1.5, size and surface correction co-efficients are 0.85 and 0.62 respectively. Take the endurance limit as half the ultimate strength. **(15 Marks)**

4 a. A flat circular plate is used to close the flanges end of a pressure vessel of internal diameter 300 mm. The vessel carries a fluid at a pressure of 0.7 N/mm^2. A soft copper gasket is used to make the joint leak proof. 12 bolts are used to fasten the cover plate onto pressure vessel. Find the size of bolts so, that the stress in the bolts is not exceed 100 MPa. **(10 Marks)**

b. The structural connection shown in Fig. Q4 (b) is subjected to an eccentric load P of 10 kN, with an eccentricity of 500 mm. The centre distance between bolts 1 and 3 is 150 mm and the centre distance between bolts 1 and 2 is 200 mm. All bolts are identical. The bolts are made of plain carbon steel having yield strength of 400 MPa and the factor of safety is 2.5. Determine the size of bolts. **(10 Marks)**

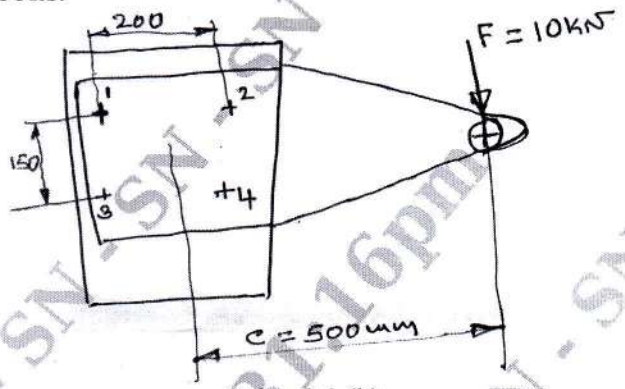

Fig. Q4 (b)

PART – B

5 A horizontal piece of commercial shafting is supported by two bearings 1.5 mts apart. A keyed gear 20° involute and 175 mm in diameter is located 400 mm to the left of the right bearing and is driven by a gear directly behind it. A 600 mm diameter pulley is keyed to the shaft 600 mm to the right of the left bearing and derives a pulley with a horizontal belt directly behind it. The tension ratio of the belt is 3 : 1, with the slack side on top. The drive transmits 45 kW at 330 rpm. Take $K_b = K_t = 1.5$. Calculate the necessary diameter of the shaft and angular deflections in degrees. Use allowable shear stress 40 MPa and G = 80 GPa. **(20 Marks)**

6 a. Design a socket and Spigot type cotter joint to sustain an axial load of 100 KN. The material selected for the joint has the following design stresses $\sigma_t = 100$ MPa, $\sigma_c = 150$ MPa and $\tau = 60$ MPa. **(10 Marks)**

b. Design a protected type cast iron flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted to be 20% greater than the full load torque. The allowable shear stress in the bolt is 60 MPa and allowable shear stress in the flange is 40 MPa. **(10 Marks)**

7 a. Design a double riveted butt joint to connect two plates 20 mm thick. The joint is zig-zag riveted and has equal width cover plates. The allowable tensile stress for the plate is 100 MPa. The allowable shear and crushing stresses for rivet material are 60 MPa and 120 MPa respectively. Calculate the efficiency of the joint. The joint should be leak proof. **(10 Marks)**

b. A solid circular shaft 25 mm diameter is welded to a support by means of a fillet welding as shown in Fig. Q7 (b). Determine the leg dimensions of the weld if the permissible shear stress is 95 MPa. **(10 Marks)**

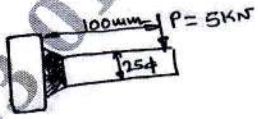

Fig. Q7 (b)

8 a. Explain self locking and overhauling in power screws. **(05 Marks)**

b. A Sluice gate weighing 600 kN is raised and lowered by two 75 mm square threaded screw. The screw are operated by a 600 rpm motor. The coefficient of collar friction is 0.03 and co-efficient of thread friction is 0.14. The outer diameter of the collar is 100 mm and inner diameter is 50 mm. The gate is to be raised at a rate of 0.6 mts/min. Determine the speed of screw and power required to raise, take $\eta = 75\%$ of reduction drive. **(15 Marks)**

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