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10ME52

Fifth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer FIVE full questions, selecting at least TWO questions from each part.***
2. Use of machine design data handbook is permitted.

PART – A

1 a. A 50 mm steel rod supports a 9 kN load and in addition to this a torsional moment of 100 N-m is applied on it as shown in Fig.Q1(a). Determine the maximum tensile and maximum shear stresses. **(10 Marks)**

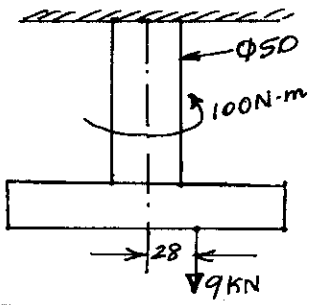

Fig.Q1(a)

b. Briefly discuss three dimensional stress field and stress tensor. **(10 Marks)**

2 a. A mild steel shaft of 60 mm diameter is subjected to bending moment of 25×10^5 N-mm and torque M_t . If the yield stress in tension is 300 N/mm^2, find the maximum value of torque without causing yielding of the shaft according to
i) Maximum shear stress theory of failure and ii) Maximum distortion theory of failure.
Adopt a factor of safety of 1.5. **(10 Marks)**

b. A mass of 500 kg is being lowered by means of steel wire rope having cross sectional area 250 mm^2. The velocity of the weight is 0.5 m/sec, when the length of the extended rope is 20 m, the sheave gets stuck up. Determine the stress induced in the rope due to sudden stoppage of the sheave. Neglect friction. Take E = 190 GPa. **(10 Marks)**

3 A transmission shaft carries a pulley midway between two bearings. The bending moment at the pulley varies from 200 N-m to 600 N-m, as the torsional moment of the shaft varies from 70 N-m to 200 N-m. The frequencies of variation of bending and torsional moments are equal to the shaft speed. The shaft is a made of steel FiE 400 (σ_U = 540 MPa, σ_{yt} = 400 MPa). The corrected endurance strength of the shaft is 200 MPa. Determine the diameter of the shaft using a factor of safety of 2. **(20 Marks)**

4 a. An M10 steel bolt of 125 mm long is subjected to an impact load. The kinetic energy absorbed by the bolt is 2.5 J. Determine: i) Stress in the shank of the bolt if there is no threaded position between the nut and the bolt head. ii) Stress in the shank if the area of the shank is reduced to that of the root area of the thread or the entire length of bolt is threaded. **(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 at 1 and 3 is 150 mm and the centre distance between 1 and 2 is 200 mm. All the bolts are identical. The bolts are made of plain carbon steel having yield strength in tension of 400 MPa and the factor of safety is 2.5. Determine size of the bolts. **(10 Marks)**

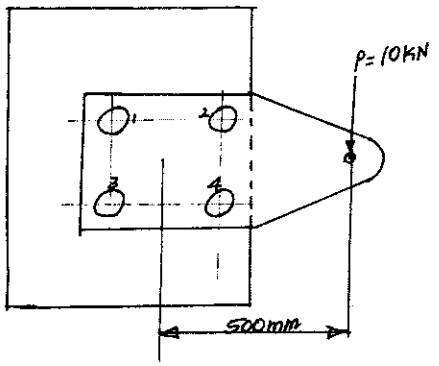

Fig.Q4(b)

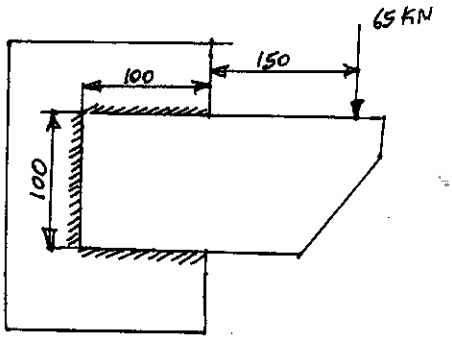

Fig.Q7(a)

PART – B

5 A horizontal piece of commercial shafting is supported by two bearings 1.5 m 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 drives a pulley with a horizontal belt directly behind it. The tension ratio of the belt is 3 to 1 with a slack side on top. The drive transmits 45 kW at 330 rpm. Take $C_m = C_t = 1.5$. Calculate the necessary shaft diameter and angular deflection in degrees. Use allowable shear stress 40 MPa and $G = 80\times10^9$ N/m^2. **(20 Marks)**

6 a. Design a cast iron flange coupling to connect two shafts of 45 mm diameter is to transmit 20 kW power at 400 rpm. The permissible shear strength for the shaft, bolt and key is 50 N/mm^2 and the permissible compressive stress is 120 N/mm^2. The permissible shear strength for cast iron is 15 N/mm^2. Assume starting torque is 30 percent higher than the nominal torque. Design the coupling assuming the bolts are fitted in reamed holes. **(12 Marks)**

b. Design the assembly of a knuckle joint to connect two mild steel rods subjected to an axial pull of 100 kN. The allowable stress for rods and pin are 100 MPa, 130 MPa and 60 MPa in tension, crushing and shear respectively. The bending of the pin is prevented by selection of proper fit. **(08 Marks)**

7 a. Determine the size of the weld required for an eccentrically loaded weld as shown in Fig.Q7(a). Assume steady load and fillet weld. **(08 Marks)**

b. Design a triple rivetted butt joint to join two plates of thickness 10 mm. The pitch of rivets in the extreme rows, which are in single shear is twice the pitch of rivets in the inner rows which are double shear. The design stresses of the materials of the main plate and the rivets are as follows:
For plate material in tension $\sigma_t = 120$ MPa, for rivet material in compression $\sigma_c = 160$ MPa, for rivet material in shear $\tau = 80$ MPa. **(12 Marks)**

8 a. Explain self locking and overhauling in power screws. **(04 Marks)**

b. A screw jack is to lift a load of 80 kN through a height of 400 mm. Ultimate strength of screw material in tension and compression is 200 N/mm^2 and in shear 120 N/mm^2. The material for the nut is phosphor bronze for which the ultimate strength is 100 N/mm^2 in tension and 90 N/mm^2 in compression and 80 N/mm^2 in shear. The bearing pressure between the nut and the screw is not to exceed 18 N/mm^2. Design the screw and nut and check for stresses. Take FOS = 2, assume 25% overload for screw rod design. **(16 Marks)**

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