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10AU52

Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting atleast TWO questions from each part.*
2. Design data handbook is permitted.
3. Assume any missing data suitably.

PART – A

1 a. A point in a structural member subjected to plane stress in shown in Fig.Q1(a). Determine
(i) Normal and tangential stress intensities on a inclined plane at 45°.
(ii) Principal stresses and their directions
(iii) Maximum shear stress and directions. **(10 Marks)**

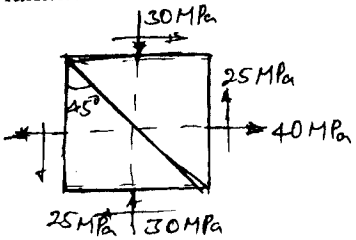

Fig.Q1(a)

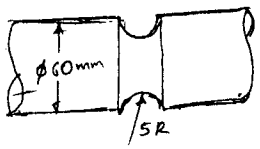

Fig.Q2(a)

b. A steel shaft is subjected to bending moment of 9 kN.m and a twisting moment of 12 kN.m. The yield strength of steel is 360 MPa in tension and compression. If a factor of safety as 2 and Poisson's ratio is 03, determine the diameter of the shaft according to
(i) Maximum shear stress theory (ii) Maximum normal stress theory
(iii) Maximum distortion energy theory. **(10 Marks)**

2 a. Determine the maximum stress induced in the semi circular grooved shaft shown in Fig.Q2(a). If it is subjected to (i) An axial load of 40 kN (ii) A bending moment of 400 N-m. (iii) A twisting moment of 500 N-m. Take stress concentration into account. **(10 Marks)**

b. An unknown weight falls through 20 mm as to a coller rigidly attached to the lower end of a vertical bar 2 m long and 500 sq. mm section. If the maximum instantaneous extension is 2 mm, what is the corresponding stress and the value of unknown weight? Take E = 200 GPa. **(10 Marks)**

3 A ground steel cantilever member shown in Fig.Q3 is subjected to a transverse load at its free end that varies from 100 N up and 200 N down and an axial load varies from 500 N compression to 1000 N tension. Determine the required diameter of the section using a factor of safety 2. The strength properties of the materials are σ_u = 550 MPa, σ_y = 480 MPa and σ_e = 270 MPa, Notch sensitively is 0.9. **(20 Marks)**

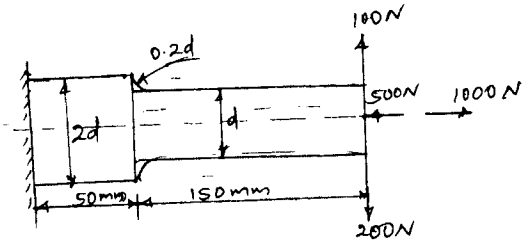

Fig.Q3

4 a. The cylinder head of a reciprocating air compressor is held in place by ten bolts. The total joint stiffness is four times the total bolt stiffness. Each bolt is tightened to an initial tension of 5 kN. The total external force acting to separate the joint is 20 kN. Find the size of the bolts so that the stress in bolts is not exceed 100 MPa. **(08 Marks)**

b. A radial drilling machine with circular base is mounted to a base plate by means of three steel bolts equally spaced on a bolt circle diameter of 0.3 m. The diameter of the circular base is 0.4 m. The spindle is positioned at a radial distance of 0.335 m from the centre of the column. During drilling operation, the spindle is subjected to a force of 4.5 kN. Determine the size of the bolts if the allowable stress in bolt material is 100 MPa. **(12 Marks)**

PART – B

5 A shaft is supported between two bearings located 0.6 m apart. Gear 'A' of pitch circle diameter 0.1 m is keyed to the shaft 0.1 m to the right of the left bearing. Gear 'B' of 0.15 m diameter keyed to the shaft 0.3 m to the right of the left bearing. Another gear 'C' of pitch circle diameter 0.08 m is keyed to the shaft 0.1 m to the left of the right bearing. Gear 'B' receives 10 kW power at 500 rpm from a mating gear mounted directly below it. Gear 'A' delivers 6 kW power to another gear mounted directly in front of it, such that the tangential force act vertically upwards. The gear 'C' delivers the remaining power to its mating gear mounted directly behind it, such that the tangential force acts vertically downwards. All gears are of 20° full depth involute form. The shaft is made up of steel which has an ultimate strength of 510 MPa and yield strength of 330 MPa. Determine the required diameter of the shaft under steady load condition using ASME code. **(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 : $\sigma_t = 100$ N/mm^2, $\sigma_c = 150$ N/mm^2 and $\tau = 60$ N/mm^2. **(10 Marks)**

b. Design a CI flanged coupling for a steel transmitting 20 kW at 1440 rpm. The allowable shear stress and crushing stress for steel shafts, keys and bolts are 40 MPa and 80 MPa respectively. The allowable shear stress for CI flange is 10 MPa. **(10 Marks)**

7 a. Design a longitudinal double riveted double strap butt joint with unequal straps for a pressure vessel. The internal diameter of the pressure vessel is 1 m and is subjected to an internal pressure of 2.2 MPa. The pitch of the rivet in the outer row is to be double the pitch in the inner row. The allowable tensile stress in the plate is 124 MPa. The shear and crushing of the rivets are 93 MPa and 165 MPa respectively. The resistance of the rivets in double shear is to be taken as 1.875 times that of single shear. **(10 Marks)**

b. One end of a rectangular bar of 120mm × 70mm cross section is welded to a vertical support by four fillet welds along its circumference. A steady transverse load of 10 kN is applied at the free end of the bar of length 160 mm and is parallel to 120 mm side. Determine the size of weld if the allowable stress in the material is limited to 115 MPa. **(10 Marks)**

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

b. A single start square threaded power screw is used to raise a load of 120 kN. The screw has a mean diameter of 24 mm and four threads per 24 mm length. The mean collar diameter is 40 mm. The coefficient of friction is estimated as 0.1 for both the thread and the collar.

(i) Determine the major diameter of the screw.
(ii) Estimate the screw torque required to raise the load.
(iii) Estimate overall efficiency
(iv) If collar friction is eliminated, what minimum value of thread coefficient is needed to prevent the screw from overhauling? **(16 Marks)**

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