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10ME52

Fifth Semester B.E. Degree Examination, Dec.2013/Jan.2014
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. ***Using of design data hand book is permitted.***
3. ***Assume missing data suitable.***

PART – A

1 a. Explain : (i) Mechanical engineering design (ii) Standards in design. **(04 Marks)**

b. A point in a structural member subjected to plane stress shown in Fig. Q1 (b). Determine the principal stresses and their direction. **(08 Marks)**

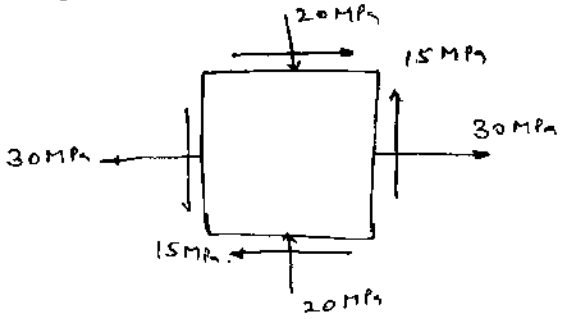

Fig. Q1 (b)

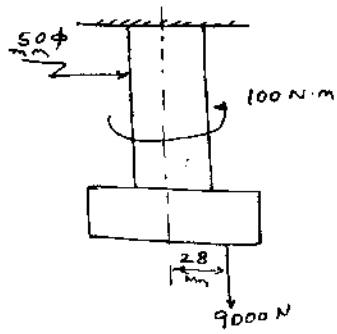

Fig. Q1 (c)

c. A 50 mm diameter steel rod supports a 9.0 kN load and in addition is subjected to a torsional moment of 100 N-m as shown in Fig. Q1 (c). Determine the maximum tensile and the maximum shear stress. **(08 Marks)**

2 a. In a plate of C45 steel (σ_y = 353 MPa) subjected to a system of loads, following stresses are induced at critical point : σ_x = 150 N/mm^2, σ_y = 100 N/mm^2 and τ_{xy} = 50 N/mm^2. Find the factor of safety according to,
(i) Maximum normal stress theory.
(ii) Maximum shear stress theory.
(iii) Distortion energy theory. **(08 Marks)**

b. Determine the safe load that can be carried by a bar of rectangular cross section shown in Fig. Q2 (b) limiting the maximum stress to 130 MPa taking stress concentration into account. **(06 Marks)**

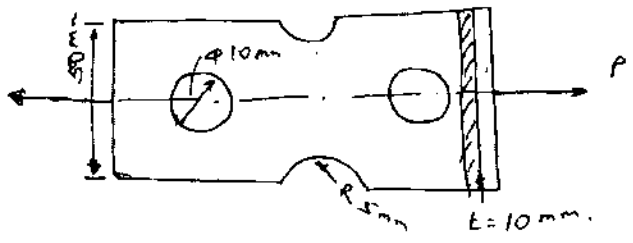

Fig. Q2 (b)

c. An unknown weight falls through 20 mm as to a collar rigidly attached to the lower end of a vertical bar 2 meter 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. **(06 Marks)**

3 a. Derive the Soderberg equation. **(05 Marks)**

b. A hot rolled steel rod is subjected to a torsional load that varies from +330 N.m, clockwise to 110 N.m counter clockwise and an applied bending moment varies from +440 N.m to –220 N.m. The rod is of uniform cross section. Determine the required rod diameter. The material has an ultimate tensile strength of 550 MPa and yield strength of 410 MPa. Design is based as a factor of safety of 1.5. Take the endurance limit as half of the ultimate strength. **(15 Marks)**

4 a. A cylinder head is fastened to the cylinder of an air compressor using 8 numbers of bolts. Inner diameter of cylinder is 300 mm. The pressure inside the cylinder varies from zero to a maximum pressure of 1.5 N/mm^2. The stresses for the bolt material may be taken as $\sigma_{ut} = 500$ N/mm^2, $\sigma_y = 300$ N/mm^2 and $\sigma_{en} = 240$ N/mm^2. The bolts are tightened with initial preload of 1.5 times the steam load. A copper asbestos gasket is used to make the joint leak proof. Assuming factor of safety 2.5, find the size of bolt. Neglect stress concentration factor. **(10 Marks)**

b. A M10 steel bolt of 125 mm long is subjected to an impact load. The kinetic energy absorbed by the bolt is 2.5 Joules. Determine (i) Stress in the shank of the bolt if there is no threaded portion between the nut and the bolt head. (ii) Stress in the shank of the area of the shank is reduced to that of the root area of the threaded or the entire length of the bolt is threaded. **(10 Marks)**

PART – B

5 A commercial shaft 1 metre long supported between bearings has a pulley of 600 mm diameter weighing 1 kN, driven by a horizontal belt drive keyed to the shaft at a distance of 400 mm to the left of th e right bearing and receives 25 kW at 1000 rpm. Power from the shaft is transmitted from the 20° spur pinion of a pitch circle diameter 200 mm which is mounted at 200 mm to the right of the left bearing to a gear such that tangential force on the gear acts vertically upwards. Take the ratio of the belt tension is 3. Determine the standard size of the shaft based on maximum shear stress theory. Assume $C_m = 1.75$, $C_t = 1.25$ **(20 Marks)**

6 a. Design a socket and spigot type cotter joint to sustain and 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 cast iron flanged couplings for a steel shaft transmitting 100 kW at 250 rpm. Take the allowable shear stress for the shaft as 40 N/mm^2 . The angle of twist is not to exceed 1° in a length of 20 diameters. Allowable shear stress for the bolts is 13 N/mm^2. The allowable shear stress in the flange is 14 N/mm^2. for the key shear stress is 40 N/mm^2 and compressive stress is 80 N/mm^2. **(10 Marks)**

7 a. A bracket having a load of 15 kN is to be welded as shown in Fig. Q7 (a). Find the size of weld required of allowable shear stress is not to exceed 80 N/mm^2. **(08 Marks)**

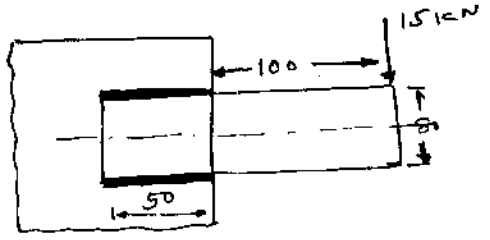

Fig. Q7 (b)

7 b. Design a double riveted butt joint with two cover plates for the longitudinal beam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume an efficiency of 75%, allowable tensile stress in the plate of 90 N/mm^2, allowable crushing stress of 140 N/mm^2 and an allowable shear stress in the rivet of 50 N/mm^2. **(12 Marks)**

8 a. Explain overhauling of screws. Derive the condition for self locking of square thread with collar friction. **(05 Marks)**

b. A weight of 500 kN is raised at a speed of 6 m/min by a two screw rods with square threads of 50 ×8 cut on them. The two screw rods are driven through level gear drives by a motor. Determine (i) The torque required to raise the load (ii) The speed of rotation of the screw rod assuming the threads are double start (iii) The maximum stresses induced in screw rod. (iv) The efficiency of screw drive. (v) The length of nuts for the purpose of supporting the load. **(15 Marks)**

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