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10AU52

Fifth Semester B.E. Degree Examination, Dec.2015/Jan.2016
Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain principal stresses and principal planes. **(03 Marks)**

b. At a point in a member, the stresses act as shown in Fig. Q1 (b). Determine the values of normal and tangential stresses on a plane inclined at 45° with vertical. **(07 Marks)**

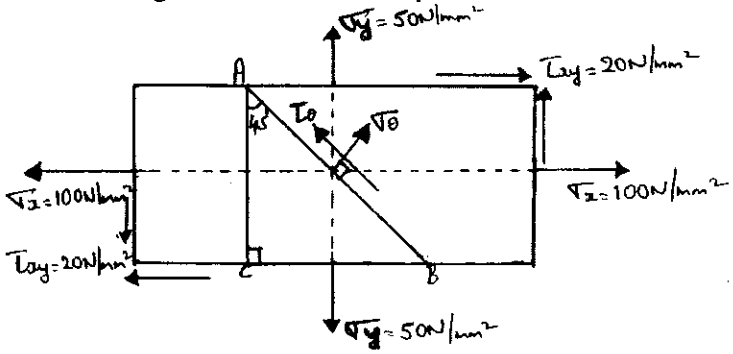

Fig. Q1 (b)

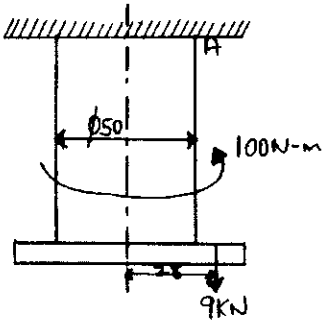

Fig. Q1 (c)

c. A 50 mm diameter steel rod supports a load of 9 kN and in addition is subjected to torsional moment of 100 N-m. Determine the maximum tensile and maximum shear stresses. Refer Fig. Q1 (c). **(10 Marks)**

2 a. Determine the maximum stress induced in the following cases taking stress concentration factor into account:

i) A rectangular plate of size 50mm × 80mm with a hole of 10 mm diameter drilled at the centre is loaded in axial tension of 10 kN. The thickness of plate is 10 mm.

ii) A circular shaft of 45 mm diameter stepped down to 30 mm diameter with fillet radius of 6 mm subjected to twisting moment of 150 N-m. **(10 Marks)**

b. A mass of 600 kg falls through a height of h at the midpoint of a simply supported beam of span 4.5 meters. Determine the value of h such that the maximum stress induced in the beam does not exceed 160 MPa. The section modulus of section of beam may be taken as 2×10^5 mm^3 and second moment of Inertia = 10^4 mm^4. Use E = 200 GPa. **(10 Marks)**

3 a. Derive Soderberg's equation with usual notations. **(06 Marks)**

b. A Cantilever beam shown in Fig. Q3 (b) is subjected to load varying from P to 3P. Determine the value of P. The material of beam has $\sigma_u = 620.8$ MPa, $\sigma_y = 400.1$ MPa and $\sigma_{-1} = 345.2$ MPa. The stress concentration factor may be taken as 1.4. Analyse the member at change of cross section only. Use F.O.S = 3. **(14 Marks)**

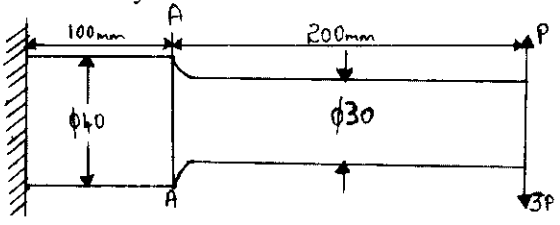

Fig. Q3 (b)

4 a. Design a cotter joint to sustain an axial load of 100 kN. The material selected for the joint has the following design stresses: $\sigma_t = 120$ MPa, $\sigma_c = 160$ MPa and $\tau = 80$ MPa. **(10 Marks)**

4 b. A flange coupling is used to connect two co-axial shafts of diameter 80 mm to transmit 60 kW at 200 rpm, 6, M14×1.5 bolts are used on a bolt circle diameter of 240 mm. The hub diameter is 150 mm and flange thickness is 20 mm. Determine,
i) The shear stress induced in shaft.
ii) The shear stress induced in bolts.
iii) The shear stress induced in key taking $\sigma_c = 80$ MPa.
iv) The shear stress induced in flanges. **(10 Marks)**

PART – B

5 A commercial steel shaft is required to sustain a torque of 450 N-m and bending moment of 300 N-m. Determine:
i) The diameter of solid shaft required.
ii) The dimensions of hollow shaft taking inside diameters equal to 0.8 times the outside diameter.
iii) Percentage of saving in weight of material by using hollow shaft. **(20 Marks)**

6 a. A bracket is fixed to the wall by means of four bolts and loaded as shown in Fig. Q6 (a). Calculate the size of bolts if the load is 10 kN and the design shear stress for bolt material is 40 MPa. **(10 Marks)**

b. The cylinder head of a steam engine is held in position by 10 bolts. The diameter of cylinder is 400 mm and the maximum pressure of steam is 1 MPa. A copper gasket is used to make the joint leak proof. Determine the standard size of bolts required by taking the design tensile stress for bolt material equal to 90 MPa. **(10 Marks)**

7 a. Design a triple riveted lap joint with zig-zag riveting for steel plates 20 mm thick using $\sigma_t = 90$ N/mm^2, $\sigma_c = 120$ N/mm^2 and $\tau = 60$ N/mm^2. **(10 Marks)**

b. Design the longitudinal joint for a boiler of diameter 2 m taking the permissible pressure as 2.5 MPa. Assume the tensile, shear and compressive stresses for the materials of shell and rivets as 90 MPa, 60 MPa and 120 MPa respectively. **(10 Marks)**

8 a. A steel plate welded by fillet welds to a structure is loaded as shown in Fig. Q8 (a). Calculate the size of weld if the load is 35 kN and allowable shear stress for the weld material is 90 MPa. **(12 Marks)**

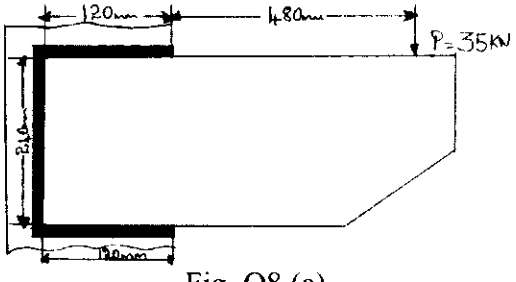

Fig. Q8 (a)

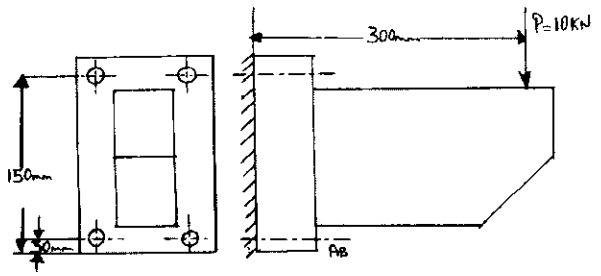

Fig. Q6 (a)

b. A power screw for a jack has square threads of proportion $50 \times 42 \times 8$, while the coefficient of friction at the threads is 0.1 and that of collar is 0.12. Determine the weight that can be lifted by the jack through an effort of 400 N applied through a hand lever of span 400 mm. **(08 Marks)**

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