Fifth Semester B.E. Degree Examination, Dec.09/Jan.10
Design of Machine Elements - I

me: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, choosing at least two from each part.*
2. Use of machine design data hand book is permitted.

PART-A

1.a. A point in a structural member subjected to plane stress is shown in Fig. Q1(a). Dtrmine the following :
i) Normal and tangential stress intensities on a plane inclined at 45°.
ii) Principle stresses and their directions.
iii) Maximum shear stress and the direction of plane on which they occur. **(10 Marks)**

b. A steel shaft is subjected to a bending moment of 9 kN m and a twisting moment of 12 kNm. The yield strength of steel is 360 MPa in tension and compression and the Poisson's ratio is 0.3. If a factor of safety of 2 with respect to failure is specified, determine the permissible diameter of the shaft according to –
i) Maximum shear stress theory of failure
ii) Maximum normal stress theory of failure
iii) Maximum distortion theory of failure. **(10 Marks)**

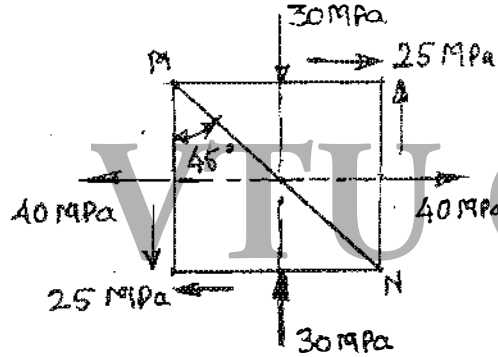

Fig. Q1(a)

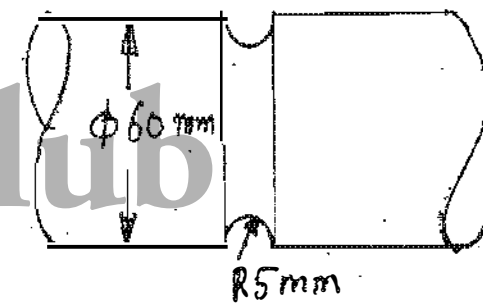

Fig. Q2(a)

2.a. Determine the maximum stress induced in the semi circular grooved shaft shown in Fig. Q 2(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 Nm. Take the stress concentration into account. **(10 Marks)**

b. A weight 600 N drops through a height of 20 mm and impacts the center of 300 mm long simply supported circular cross section beam. Find the diameter of the beam and the maximum deflection, if the allowable stress is limited to 90 MPa. Neglect the inertia effect and 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 to 200 N down as an axial load varies from 500 N compressions to 1000 N tension. Determine the required diameter of the section using a factor of safety 2. The strength properties of the material are : ultimate strength = 550 MPa, yield strength = 480 MPa and endurance limit = 270 MPa. **(20 Marks)**

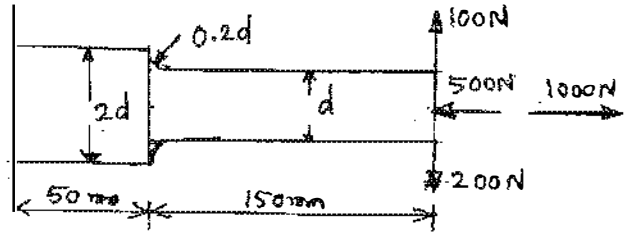

Fig. Q3

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 in not to 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 0.3m. The diameter of the circular base is 0.4m. 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 limited to 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 0.1m to the right of the left bearing. Gear 'B' of 0.15 m diameter is 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 0.1m to the left of the right bearing. Gear 'B' receives 10 kW power at 500 rpm from another gear mounted directly infront of it, such that the tangential force acts 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 of steel which has an ultimate strength of 510 MPa and a 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 knuckle joint to connect two mild steel rods to sustain an axial pull of 150 kN. The pin and the rods are made of same material. Assume the working stresses in the material as 80 MPa in tension, 40 MPa in shear and 120 MPa in crushing. **(10 Marks)**

b. Design a bushed pin type flexible coupling to connect a motor shaft to a pump shaft transmitting 20 kW power at 1440 rpm. The allowable shear and crushing stress for steel shafts, keys and pins are 40 MPa and 80 MPa respectively. The allowable shear stress for the cast iron flange is 10 MPa and the allowable bearing pressure for rubber bush is 0.5 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 N/mm^2. 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 N/mm^2. The allowable shear and crushing of the rivets are 93 N/mm^2 and 165 N/mm^2 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 120 mm x 70 mm cross section is welded to a vertical support by four fillet welds along its circumstance. 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 the weld, if the allowable stress in the material is limited to 115 Mpa. **(10 Marks)**

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

b. A single start square threaded screw is used to raise a load of 10 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 over all efficiency
iv) If collar friction is eliminated, what minimum value of thread coefficient is needed to prevent the screw from overhauling? **(15 Marks)**

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