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10ME52

Fifth Semester B.E. Degree Examination, June/July 2013
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 design data Hand book is permitted.

PART – A

1 a. What are the basic requirements of machine elements? Explain briefly. **(05 Marks)**

b. What are the factors to be considered for selection of material for a machine component? **(05 Marks)**

c. A hollow shaft of 40 mm diameter and 25 mm inner diameter is subjected to a twisting moment of 118 N-m, a axial thrust of 9806 N and a bending moment of 79 N-m. Calculate the maximum compressive and shear stresses. **(10 Marks)**

2 a. The brasses of an automobile engine connecting rod have worn, so as to allow play which gives shock loading equivalent to a weight of 5886 N falling through a height of 0.2 mm. The connecting rod is 250 mm long and has a cross sectional area of 3×10^{-4} m^2. Determine the stress induced in the connecting rod. Compare the maximum stress induced with that of a static load of 5886 N. **(06 Marks)**

b. A bolt is subjected to a direct tensile load of 30 kN and a transverse shear force of 15 kN. Material of the bolt has a normal stress of 350 MPa at yield and Poisson's ratio of 0.25. Compute the root diameter of the bolt according to:
i) Maximum shear stress theory of failure and
ii) Von Mise's criterion for failure.
Hence suggest suitable size of the bolt. Take a value of 3 for factor of safety. **(07 Marks)**

c. Determine the maximum stress induced in the following cases taking stress concentration into account:
i) A rectangular plate 50 mm wide, 8 mm thick and with a central hole of 10 mm is loaded in axial tension of 14.7 kN.
ii) A stepped shaft, stepped down from 45 mm to 30 mm with a fillet radius of 6 mm is subjected to a twisting moment of 98 N-m. **(07 Marks)**

3 a. Derive Soderberg's equation for designing of a machine element, with change in cross section, to sustain loads that fluctuate between two limits. **(05 Marks)**

b. A hot rolled steel shaft is subjected to a torsional moment that varies from 300 N-m clockwise to 100 N-m counterclockwise as the bending moment at the critical section varies from 400 N-m to – 200 N-m. Neglecting the stress concentration effect, determine the required shaft diameter. The material has an ultimate strength of 550 MPa and a yield strength of 410 MPa. Take the endurance limit as half the ultimate strength and a factor of safety as 2. Assume surface, size and load factor for bending as 1.111, 1.1765 and 1 and that for torsion as 1.05263, 1.1765 and 1.7 respectively. **(15 Marks)**

4 a. An M20×2 steel bolt of 100 mm long is subjected to impact load. The energy absorbed by the bolt is 2 N-m,
i) Determine the stress in the shank of the bolt if there is no threaded portion between the nut and bolt head.
ii) Determine the stress in the shank if the entire length of the bolt is threaded.
Assume modulus of elasticity for steel as 206 GPa. **(08 Marks)**

4 b. Determine the size of the bolts for the loaded bracket shown in Fig. Q4 (b), if the allowable tensile stress in the bolt material is limited to 80 MPa. **(12 Marks)**

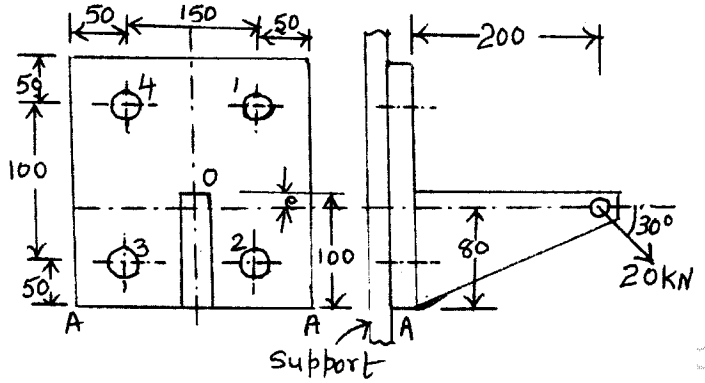

Fig. Q4 (b)

PART – B

5 a. Prove that a hollow shaft is stronger and stiffer than a solid shaft of same length, weight and material. **(08 Marks)**

b. A hollow propeller shaft of 0.6 m outside diameter and 0.3 m inside diameter is used to drive a propeller of a marine vessel. The shaft is mounted on bearings 5 m apart and it transmits 6 MW power at 100 rpm. The maximum axial propeller thrust is 600 kN and shaft weighs 60 kN. Determine i) Maximum shear stress developed in the shaft and ii) Angle of twist of the shaft between the bearings. Assume the modulus of rigidity as 84 GPa. **(12 Marks)**

6 a. If a shaft and key are made of same material, determine the length of the key required in terms of shaft diameter, taking key width $b = \frac{d}{4}$ and key thickness $h = \frac{3d}{16}$. Assume keyway factor as 0.75. **(06 Marks)**

b. Design a rigid flange coupling to transmit 18 kW at 1440 rpm. The allowable shear stress in the cast iron flange is 4 MPa. The shaft and keys are made of AISI 1040 annealed steel with ultimate strength and yield stress values as 518.8 MPa and 353.4 MPa, respectively. Use ASME code to design the shaft and the key. **(14 Marks)**

7 a. A bracket is supported by means of four rivets of same size as shown in Fig. Q7 (a). Determine the diameter of the rivet if the maximum shear stress in the rivet is 90 N/mm^2. **(10 Marks)**

b. Determine the maximum normal stress and the maximum shear stress in the weld shown in Fig. Q7 (b) **(10 Marks)**

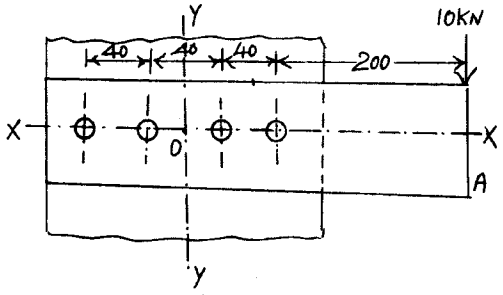

Fig. Q7 (a)

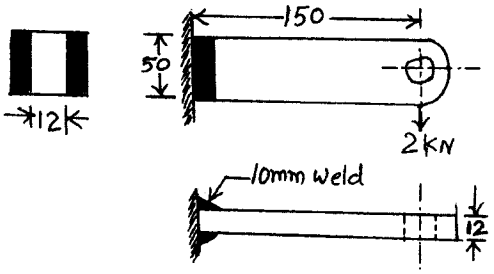

Fig. Q7 (b)

8 Design completely the screw, handle and the nut of a screw jack of capacity 40 kN. The maximum lift is limited to 0.2 m. The screw and the handle are made of C40(40C8) steel and the nut and the cup are made of cast iron. Also find the efficiency of the screw. Check the screw for buckling load. **(20 Marks)**

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