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06ME52

Fifth Semester B.E. Degree Examination, Dec.2014/Jan.2015
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 handbook is permitted.

PART – A

1 a. Explain the material code for any two engineering material. **(02 Marks)**

b. Explain in brief, any six important factors governing the selection of materials for a machine member. **(06 Marks)**

c. A machine member 50 mm diameter and 200 mm long can be treated as a cantilever for stress analysis. The loading of the member is shown in Fig.Q1(c). Determine the maximum and minimum normal stress and maximum shear stress at critically stressed point "A" and "B". **(12 Marks)**

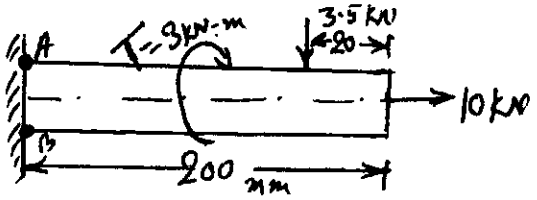

Fig.Q1(c)

2 a. A bolt is subjected to a direct axial tensile load of 20 kN and a shear load of 15 kN. Material of the bolt is ductile and has a yield strength of 360 N/mm^2 and Poisson ratio of 0.25. Compute the root diameter of the bolt according to (i) Maximum shear stress theory (ii) Maximum normal stress theory (iii) Maximum strain energy theory. Factor of safety = 3. **(09 Marks)**

b. Discuss the statement "In static loading stress concentration in ductile material is not so serious as in brittle material". **(03 Marks)**

c. Find the maximum stress induced in the following cases shown in Fig.Q2(c)(i) and Fig.Q2(c)(ii) taking stress concentration into account. **(08 Marks)**

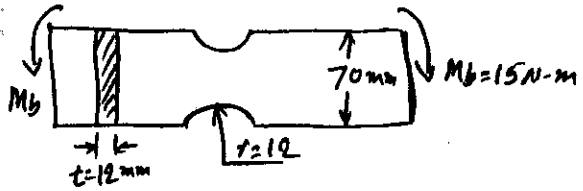

Fig.Q2(c)(i)

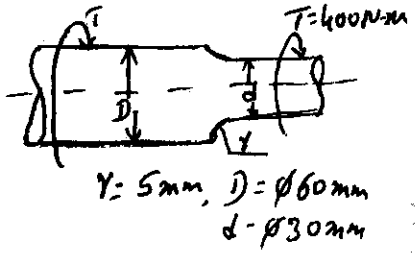

Fig.Q2(c)(ii)

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

b. A steel cantilever of 200 mm long is subjected to combined loading is as shown in Fig.Q3(b). The cantilever is of circular cross-section. Determine its diameter taking a factor of safety of 2. Take σ_y = 330 MPa, σ_{en} = 300 MPa, stress concentration factor for static axial and bending load is 1.64 and 1.44 respectively. Choose proper values of modifying factors "A", "B" and "C" from data handbook. Notch sensitivity index is 0.9. **(15 Marks)**

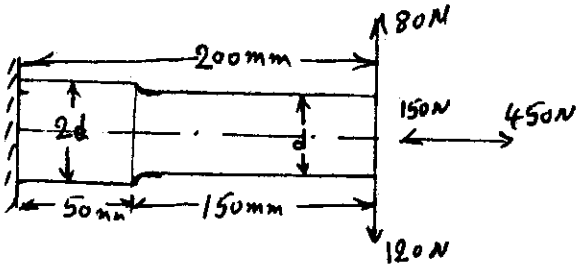

Fig.Q3(b)

4 a. A bolt connects two plates of an assembly whose combined stiffness is 4 times the stiffness of bolt. The joint is subjected to an external load which varies from 2 kN to 6 kN. The initial tightening force on bolt is 4 kN. The bolt used is M16 coarse thread and is made up of SAE 1025 annealed steel. Take A = 1.0, B = 0.85, C = 0.9, K_{ft} = 5.0. Determine the factor of safety in design. **(10 Marks)**

b. Determine the size of the bolt for the loaded bracket as shown in Fig.Q4(b). All the bolts are identical. The bolts are made from plane carbon steel 30C8 and factor of safety is 2.5. Take $\sigma_y = 400$ N/mm^2. **(10 Marks)**

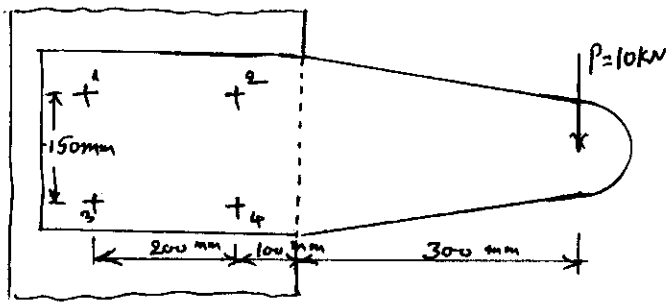

Fig.Q4(b)

PART – B

5 A shaft is supported by two bearings placed 1.2 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and $\mu = 0.25$. Determine the suitable diameter for a solid shaft allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley. **(20 Marks)**

6 a. Design a knuckle joint to transmit 150 kN. The design stress may be taken as 75 MPa in tension, 60 MPa in shear and 150 MPa in crushing. **(08 Marks)**

b. Design a flange coupling to connect the shafts of a motor and centrifugal pump for the following specification.

Total head = 20 m ; Pump output = 3000 litres/minute ;
Pump speed = 600 rpm ; Pump efficiency = 70%

Select C40 steel for shaft and C35 steel for bolts with factor of safety 2. Use allowable shear stress in the cast iron flange equal to 15 N/mm^2. **(12 Marks)**

7 a. Design a double riveted butt joint with two plates for the longitudinal seam 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 and allowable compressive stress of 140 N/mm^2 and an allowable shear stress of 56 N/mm^2 in the rivets. **(10 Marks)**

b. A shaft of rectangular cross-section is welded to a support by means of fillet welds as shown in Fig.Q7(b). Determine the size of the welds, if the permissible shear stress in the weld is limited to 75 N/mm^2. **(10 Marks)**

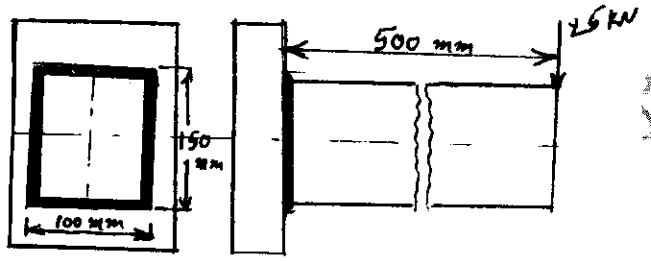

Fig.Q7(b)

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

b. A weight of 500 kN is raised at a speed of 6 m/min by two screw rods of double start square thread of 50 mm major diameter with a pitch of 8 mm. The two screw rods are driven through bevel gear drives by a motor. Determine

i) The torque required to raise the load
ii) The speed of rotation of the screw rod
iii) The maxm. Stresses induced on the cross-section of the screw rod.
iv) The efficiency of screw drive.
v) The length of nut for the purpose of supporting the load.
vi) Check for overhaul.

Take bearing pressure P_b = 15 MPa, f = 0.1. **(16 Marks)**

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