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06ME52

Fifth Semester B.E. Degree Examination, June/July 2018
Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: *1. Answer FIVE full questions, selecting atleast TWO questions from each part.*
2. Use of design hand book is permitted.
3. Missing data, if any, may be suitably assumed.

PART – A

1 a. Sketch and explain, biaxial and tri-axial stresses, stress tensor and principal stresses. **(06 Marks)**

b. The state of stress at a point in a structural member is shown in Fig.Q1(b). The tensile principal stress is known to be 84 N/mm^2. Determine i) the maximum shearing stress at the point and orientation of its plane ii) the shearing stress τ_{xy} . **(10 Marks)**

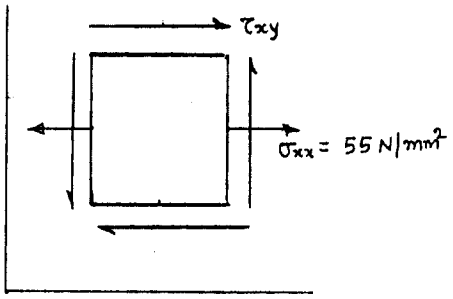

Fig.Q1(b)

c. Briefly discuss the factors influencing the selection of suitable material for machine element.

2 a. A round rod of diameter 30mm is to sustain an axial compressive load of 20 kN and twisting moment of 1.5 kN.m. The rod is made of carbon steel C40 (σ_{yt}=328.6 MPa). Determine the factor of safety as per following theories of failure:
i) Maximum principal strain theory
ii) Maximum elastic strain energy theory. **(08 Marks)**

b. A flat plate subjected to a tensile force of 5 kN is shown in Fig.Q2(b). The plate material is grey cost iron having σ_u value of 200 MPa. Determine the thickness of the plate. Factor of safety is 2.5. **(08 Marks)**

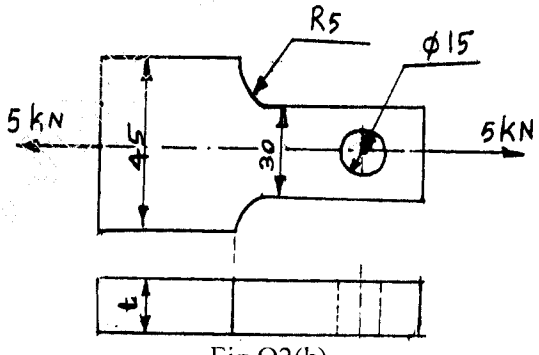

Fig.Q2(b)

Determine the maximum torsional impact that can withstand, without permanent deformation by a 100mm cylindrical shaft 5 m long and made of SAE 1045 annealed steel (τ_y = 180 MPa and G = 82 GPa). Factor of safety = 3. **(04 Marks)**

3 a. Derive the Soderberg's equation

$$\frac{1}{N} = \frac{\sigma_m}{\sigma_y} + K_{f_1} \frac{\sigma_a}{A \cdot B \cdot C \cdot \sigma_{en}}$$

where A is surface finish factor, B is size factor and C is the load factor. **(06 Marks)**

b. A hot rolled steel shaft is subjected to a torsional moment that varies from 330 Nm (clockwise) to 110 Nm (counter clockwise) as the applied bending moment at the critical section varies from +440 Nm to –220 Nm. The shaft is of uniform cross section and no key way is present at the critical section. Determine the required shaft diameter. The material has an ultimate strength of 550 MPa and yield strength of 410 MPa. Take the endurance limit as half the ultimate strength, factor of safety = 2, size factor of 0.85 and a surface finish factor of 0.62. **(14 Marks)**

4 a. A bolt carries a tensile load of 8 kN and tightening load is 3 kN. It is made of steel having allowable tensile stress of 120 Mpa. Find its size. A soft copper gasket is used. **(06 Marks)**

b. A bracket is bolted as shown in Fig.Q.4(b). All the bolts are identical and have yield strength of 400 Mpa. Determine the size of bolts assuming factor of safety as 3. **(10 Marks)**

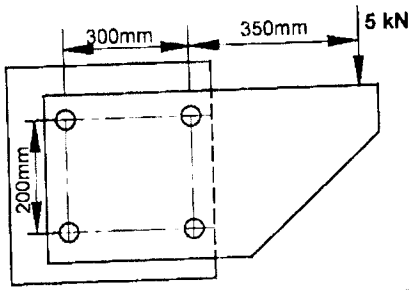

Fig.Q4(b)

PART – B

5 A horizontal piece of commercial shafting is supported by two bearings 1.5m apart. A keyed gear, 20° involute and 175 mm diameter, is located 400 mm to the left of the right bearing and is driven by a gear directly behind it. A 600 mm diameter pulley is keyed to the shaft 600 mm to the right of the left bearing and drives a another pulley by means of a belt driven inclined at 45° to the horizontal below the shaft and in front of it. The tension ratio of the belt is 3:1. The drive transmits 45 kW at 330 rpm cw when viewed from right side. The allowable shear stress for shaft material is 40 Mpa. The combined shock and fatigue factors for torsion and bending are 1.5 and 2.0 respectively. Draw the moment diagrams and calculate the necessary shaft diameter. **(20 Marks)**

6 a. Design and sketch the assembly of a cotter joint to connect two rods, subjected to an axial pull of 600 kN. The material selected for the joint has the following permissible stresses: 300 MPa in tension, 220 MPa in shear and 450 MPa in crushing. **(12 Marks)**

b. A cast iron protective type flange coupling is used to connect two shafts of 80 mm diameter. The shaft runs at 250 rpm and transmits a torque of 4300 N-m. The permissible shear stress for shaft and bolt materials is 50 MPa and permissible shear stress for flange is 8 MPa. Design the bolts, hub and flange for the coupling. **(08 Marks)**

7 a. Design a double riveted butt joint with two cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.9 MPa. Assume joint efficiency as 75%. Allowable stress in tension for the plate is 83 MPa in compression 138 MPa and shear stress in rivets may be assumed as 55 MPa. Assume chain riveted joint. **(10 Marks)**

b. A circular shaft 50 mm in diameter is welded to a support by means of a fillet weld and loaded as shown in Fig. Q7 (b). Determine the size of weld if the permissible shear stress in the weld is limited to 100 MPa. **(10 Marks)**

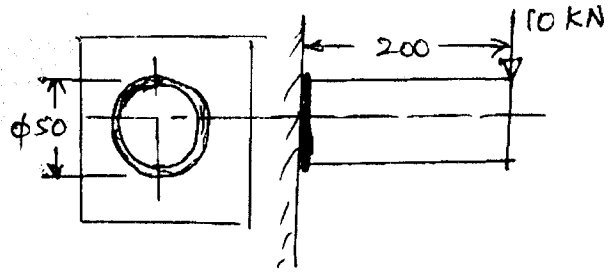

Fig. Q7 (b) All dimensions in mm

8 a. Derive an expression for the maximum efficiency of a square threaded screw and thus show that for self locking screw the efficiency is always less than 50%. **(06 Marks)**

b. The lead screw of a lathe has single start ISO metric trapezoidal threads of 52 mm nominal diameter and 8 mm pitch. The screw is required to exert an axial force of 2 kN in order to drive the tool carriage during turning operation. The thrust is carried on a collar of 100 mm outer diameter and 60 mm inner diameter. The values of co-efficient of friction at the screw threads and collar are 0.15 and 0.12 respectively. The lead screw rotates at 30 rev/min. Calculate :

i) The power required to drive the screw

ii) The efficiency of the screw. **(14 Marks)**

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