CBCS SCHEME

USN | | | | | | | | | | |

18AU53

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 100

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of design data handbook is permitted.***
3. ***Assume missing data suitably.***

Module-1

1 a. A point in a structural member subject to plane stress as shown in Fig.Q1(a). Determine the following:
(i) Normal and tangential stress on plane MN inclined at an angle of 45°.
(ii) Principal stress and their direction.
(iii) Maximum shear stress and the direction of the plane on which it occurs.

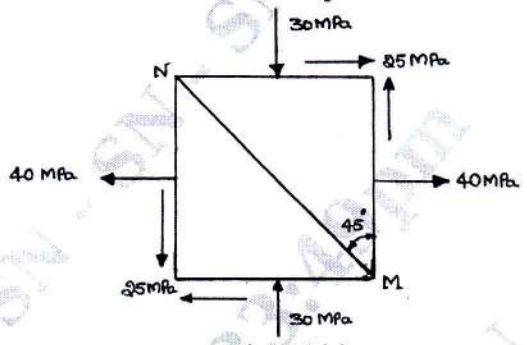

Fig.Q1(a) **(10 Marks)**

b. A mild steel bracket shown in Fig.Q1(b) is subjected to a pull of 10 kN. The bracket has rectangular cross-section whose depth is twice the width. If the allowable stress for the material is 80 N/mm^2. Determine cross-section of the bracket.

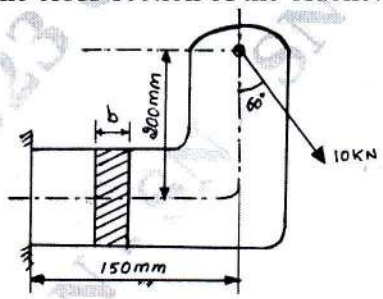

Fig.Q1(b) **(10 Marks)**

OR

2 a. A circular rod of diameter 50 mm is subjected to loads as shown in Fig.Q2(a). Determine the nature and magnitude of stress at the critical points.

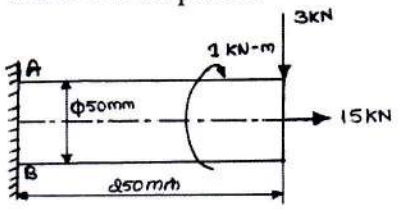

Fig.Q2(a) **(10 Marks)**

b. A mild steel shaft of 60 mm diameter is subjected to a bending moment of 25×10^5 N-mm and torque 'M_t'. If the yield point of steel in tension is 230 N/mm^2, find the maximum value of the torque without causing yielding of shaft according to:
(i) Maximum principal stress theory of failure
(ii) Maximum shear stress theory of failure
(iii) Maximum distortion energy theory of failure
Adopt a factor of safety of 1.5. **(10 Marks)**

Module-2

3 a. A notched flat plate shown in Fig.Q3(a) is subjected to bending moment of 10 N-m. Determine the maximum stress induced in the member by taking the stress concentration into account.

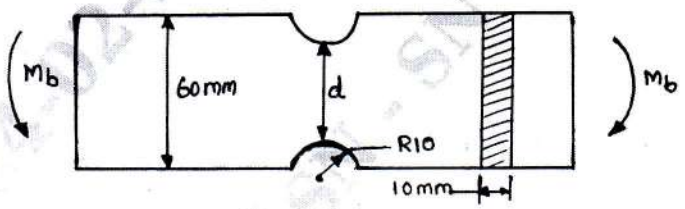

Fig.Q3(a) **(10 Marks)**

b. Determine the power that can be transmitted by a shaft as shown in Fig.Q3(b). Speed of shaft is 1200 rpm, if the allowable shear stress is 50 N/mm^2.

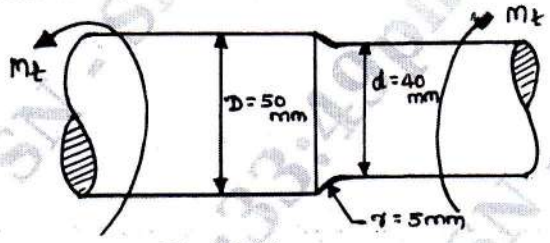

Fig.Q3(b) **(10 Marks)**

OR

4 a. An unknown weight fall through 20 mm on to a collar rigidly attached to the lower end of a vertical bar of mild steel of 2m long and 500 mm^2 section. If the maximum instantaneous extension is known to be 2 mm, what is the corresponding stress and the value of unknown weight? **(10 Marks)**

b. A steel rod (SAE 9620 oil quenched) is subjected to a tensile load which varies from 120 kN to 40 kN. Design the safe diameter of the rod using "Soderberg diagram". Adopt factor of safety as 2. Stress concentration factor as unity and correction factor for load, size and surface as 0.75, 0.85 and 0.91 respectively. Take, σ_{ut} = 1089.5 MPa, σ_{yt} = 689.4 MPa and σ_{-1} = 427 MPa. **(10 Marks)**

Module-3

5 a. Design a knuckle joint to connect two mild steel rods subjected to an axial pull of 100 kN. The allowable stress for rods and pins are 100 MPa, 130 MPa and 60 MPa in tension crushing, and shear respectively. The bending of the pin is prevented by selection of proper fit. **(10 Marks)**

b. A flange coupling used to connect two co-axial shafts of diameter 80 mm to transmit 60 kW at 200 rpm, 6 bolts of M14 × 1.5 are used on a bolt circle diameter of 240 mm. The stress in key is 80 MPa and the hub diameter is 150 mm and flange thickness is 20 mm. Determine shear stress induced in Shaft, Bolt, Key and Flange. **(10 Marks)**

OR

6 A horizontal piece of commercial shafting is supported by two bearings 1.5 m apart. A keyed gear 20° involute and 175 mm in 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 pulley with a horizontal belt directly behind it. The tension rate of belt is 3 to 1, with the slack side on top. The drive transmits 45 KW at 330 rpm. Take $K_b = K_t = 1.5$. Calculate the necessary diameter of the shaft and angular deflections in degrees. Use allowable shear stress 40 MPa and $G = 80 \times 10^9$ N/m^2. **(20 Marks)**

Module-4

7 a. A double riveted lap joint is to be made between 9 mm plates. If the safe working stress in tension, crushing and shear are 80 N/mm^2, 120 N/mm^2 and 60 N/mm^2 respectively, design the riveted joint. **(10 Marks)**

b. Determine the diameter of rivet for the joint shown in Fig.Q7(b). The allowable stress in the rivets is 100 N/mm^2.

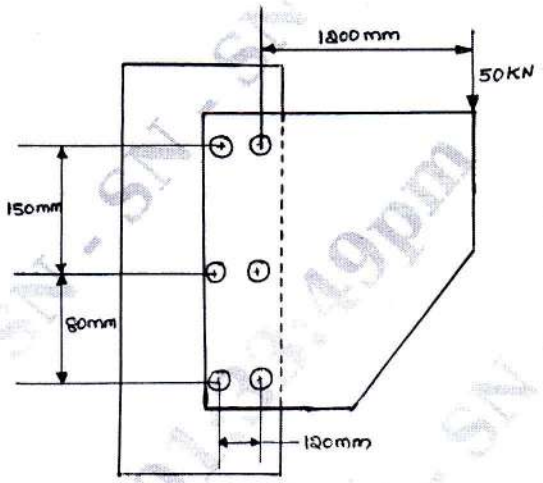

Fig.Q7(b) **(10 Marks)**

OR

8 a. A plate of 80 mm wide and 15 mm thick is joined with another plate by a single transverse weld and a double parallel weld. Determine the length of parallel fillet weld if the joint is subjected to both static and fatigue loading. Take $\sigma_t = 90$ MPa; $\tau = 55$ MPa as the allowable stress and stress concentration factor as 1.5 for transverse and 2.7 for parallel weld. **(10 Marks)**

b. Determine the size of weld required for an eccentrically loaded weld as shown in Fig.Q8(b). The allowable stress in the weld is 75 N/mm^2.

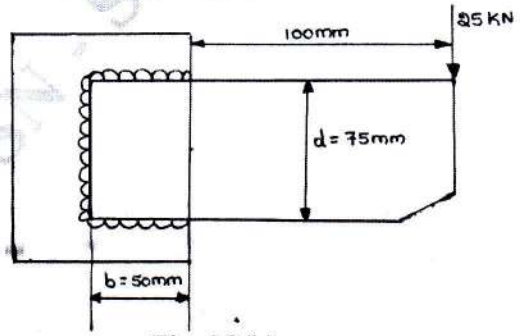

Fig.Q8(b) **(10 Marks)**

Module-5

9 a. A bracket shown in Fig.Q9(a) carries a load of 50 kN. Determine the size of bolt if the permissible tensile stress in the bolt material is 200 N/mm^2.

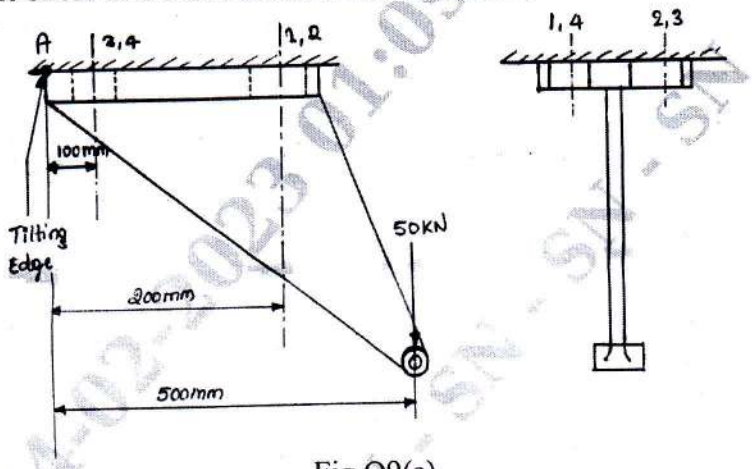

Fig.Q9(a) **(10 Marks)**

b. A bracket is fixed to the wall by means of four bolts and loaded as shown in Fig.Q9(b). Calculate the size of the bolts. If the load is 10 kN and allowable shear stress in the bolt material is 40 MPa.

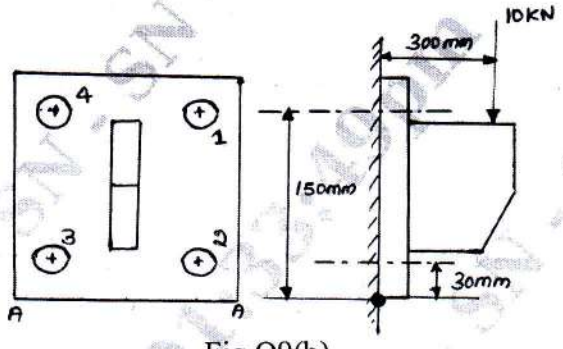

Fig.Q9(b) **(10 Marks)**

OR

10 a. A flat circular plate is used to close the flanged end of a pressure vessel of internal diameter 300 mm. The vessel carries a fluid at a pressure of 0.7 N/mm^2. A soft copper gasket is used to make the joint leak proof. Twelve bolts are used to fasten the cover plate onto pressure vessel. Find the size of bolts so that the stress in the bolts is not to exceed 100 N/mm^2. **(10 Marks)**

b. Derive an expression for torque required to raise a load and lower a load in power screws. **(10 Marks)**

* * * * *