

# CBCS SCHEME

15ME54

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023

## Design of Machine Elements – I

Time: 3 hrs.

Max. Marks: 80

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

### Module-1

- 1 a. Discuss the factors which govern the selection of an appropriate material for a machine component. (06 Marks)  
b. A shaft of 50 mm diameter is stepped down to 40 mm with a fillet radius of 5 mm and torque Mt. If the allowable shear stress is  $50 \text{ N/mm}^2$ , determine the power that can be transmitted at 1200 rpm. (10 Marks)

OR

- 2 a. Define stress concentration and show how stress concentration can be reduced for two examples with neat sketches. (06 Marks)  
b. Determine the safe load that can be carried by a rectangular bar of cross section as shown in Fig.Q2(b) limiting the maximum stress to 130 MPa taking stress concentration into account.

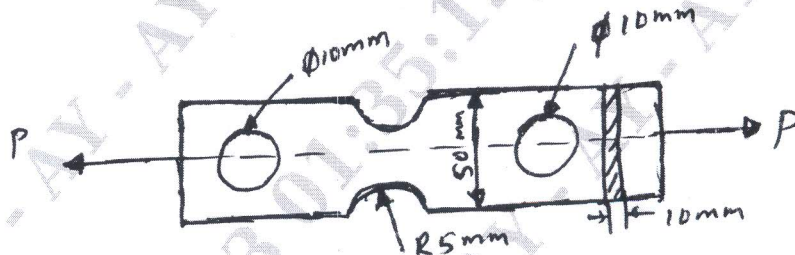


Fig.Q2(b)

(10 Marks)

### Module-2

- 3 a. Obtain an expression for impact stress induced in a member subjected to axial load. (06 Marks)  
b. A mass of 15 kg falls from a height of 250 mm at the midpoint of a simply supported beam. It is made of steel, has a length of 1m between the supports. Cross section of the beam is 60 mm  $\times$  60 mm square. Determine maximum deflection and bending stress induced in the beam due to falling mass. (10 Marks)

OR

- 4 a. Obtain Soderberg's relation for a member subjected to fatigue loading. (06 Marks)  
b. A steel connecting rod of rectangular bar cross section having depth twice that of width is subjected to a completely reversed axial load of 18 kN. The endurance stress is 300 MPa and yield stress is 420 MPa. Determine suitable cross-sectional dimensions of the connecting rod. Take size factor = 0.9, load factor = 0.7, surface factor = 0.85, stress concentration factor = 1.5, Notch sensitivity = 1, Factor of safety = 1.8. Neglect column effect. (10 Marks)

**Module-3**

- 5 A commercial steel shaft 1m long supported between bearings carries a pulley of diameter 600 mm weighing 1 kN located 400 mm to the right hand bearing and receives 25 KW at 1000 rpm by a horizontal belt drive. The power from the shaft is transmitted by a spur pinion of  $20^\circ$  pressure angle having pitch circle diameter 200 mm to a spur gear such that the tangential force on gear acts vertically upwards. The pinion is keyed to the shaft at a distance of 200 mm to the right of the left bearing. Taking the ratio of belt tensions as 3, determine the diameter of the shaft required. Use maximum shear stress theory. Take  $\tau_d = 40 \text{ N/mm}^2$ . (16 Marks)

OR

- 6 a. It is required to design a cotter joint to connect two steel rods of equal diameter. Each rod is subjected to axial tensile force of 50 kN. Design the joint and specify main dimensions. Take permissible stresses for rods in tension =  $67 \text{ N/mm}^2$ , crushing =  $134 \text{ N/mm}^2$  and for cotter in tension =  $100 \text{ N/mm}^2$ . (08 Marks)
- b. Design a knuckle joint to connect two mild steel rods. The joint has to transmit a tensile load of 80 kN. Allowable stresses for the material may be taken as  $\sigma_t = 80 \text{ MPa}$ ,  $\sigma_{cr} = 120 \text{ MPa}$ ,  $\tau = 40 \text{ MPa}$ . (08 Marks)

**Module-4**

- 7 a. A bracket attached to a vertical column by means of four identical rivets is subjected to an eccentric force of 25 kN as shown in Fig.Q7(a). Determine the diameter of rivets, if the permissible shear stress is  $60 \text{ N/mm}^2$ .

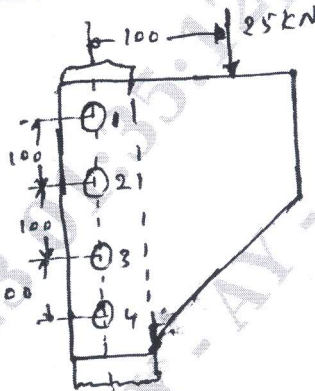


Fig.Q7(a)

(08 Marks)

- b. A bracket is supported by means of 4 rivets of same size as shown in Fig.Q7(b). Determine the diameter of rivet if the maximum stress is  $140 \text{ N/mm}^2$ .

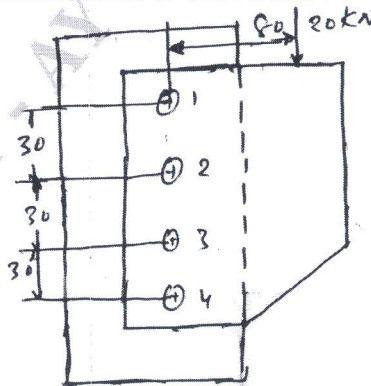


Fig.Q7(b)

(08 Marks)

OR

- 8 a. A welded connections as shown in Fig.Q8(a) is subjected to an eccentric force of 60 kN in the plane of the welds. Determine the size of welds, if the permissible shear stress for the weld is  $100 \text{ N/mm}^2$ . Assume static conditions.

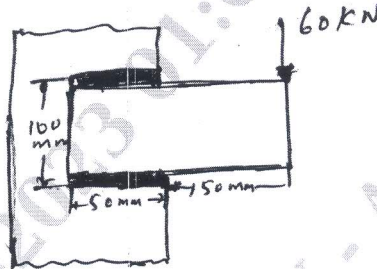


Fig.Q8(a)

(08 Marks)

- b. Determine the load carrying capacity of a welded joint as shown in Fig.Q8(b). The allowable shear stress for 10 mm weld used is 50 MPa.

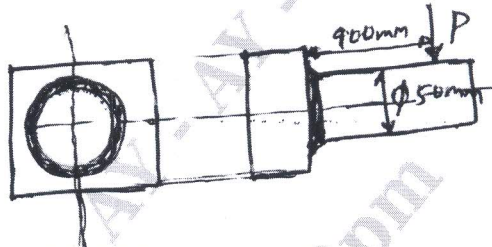


Fig.Q8(b)

(08 Marks)

Module-5

- 9 a. Explain self locking and overhauling in power screws. (06 Marks)  
 b. A bracket is bolted as shown in Fig.Q9(b). All the bolts are of same size and are made of steel having allowable tensile stress of 90 MPa and allowable shear stress of 52 MPa. Determine the size of the bolts to be used.

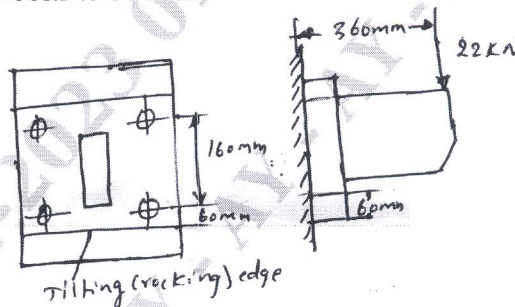


Fig.Q9(b)

(10 Marks)

OR

- 10 a. Derive the expression for torque required to lift the load on square threaded screw. (08 Marks)  
 b. The square thread of screw jack with specification  $80 \times 16$ , with a double start is to raise a load of 100 kN. The mean collar diameter is 130 mm. The coefficient of friction for the threads and the collar are respectively 0.1 mm and 0.12. Determine:  
 (i) Torque required to raise the load  
 (ii) Efficiency of the screw  
 (iii) Whether self-locking exists? (08 Marks)

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