CBCS SCHEME

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15ME54

Fifth Semester B.E. Degree Examination, June/July 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 hand book is permitted*

Module-1

1 a. List the factors which govern the selection of appropriate material for a machine component. **(05 Marks)**

b. A stepped shaft with its diameter reduced for '2d' to 'd' has a fillet radius of 0.1d. Determine the diameters of the shaft and the radius of the fillet to transmit a power of 65KW at a rated speed of 1440 rpm limiting the shear stress induced to 60 MPa. **(11 Marks)**

OR

2 a. Define Stress Concentration and show how stress concentration can be reduced for two examples with neat sketches. **(06 Marks)**

b. A cantilever beam of rectangular cross section with a depth of 150 mm is subjected to an axial tensile load of 40 kN and a transverse load of 50 kN acting downwards at the free end of 600 mm length beam. The material of the beam has allowable tensile stress of 100 MPa. Determine the width of rectangular section of the beam. **(10 Marks)**

Module-2

3 a. Derive Soderberg equation for designing members subjected to fatigue loading. **(06 Marks)**

b. Machine member is in the form of a simply supported beam of length 1 m and cross section 50mm × 60mm. It is made of steel having permissible stress of 120 MPa. Determine the safe height from which a mass of 10 kg may be allowed to fall at the midpoint of the beam. **(10 Marks)**

OR

4 A transmission shaft carries a gear midway between two bearings. The bending moment at the gear varies from – 300 N-m to +500 N-m, as the twisting moment varies from 100 N-m in c.w. direction to 200 N-m in c.c.w direction. The frequencies of variation of bending and torsional moments are equal to the shaft speed. The shaft is made of C30 steel. The endurance limit may be taken as 50% of ultimate strength. Determine the diameter of the shaft taking size factor as 0.85, surface finish factor as 0.88 and factor of safety of 2. **(16 Marks)**

Module-3

5 A power transmission shaft 1400 mm long is supported at its extreme ends. The shaft receives a power of 50 kW through a gear drive located 500 mm to the right of the left end of the shaft at a rated speed of 600 rpm. PCD of gear is 200 mm, pressure angle 20° and weight 500 N. This gear receives power from another gear directly behind. This power is delivered through a belt drive located a distance of 400 mm to the left of the right support. The belt pulley has a pitch diameter of 350 mm and weighs 800 N. The belt moving on the pulley is directed towards the observer, below the horizontal and inclined at 45° to it. The ratio of belt tensions is 3. Selecting carbon steel C40, factor of safety of 2.5 design the solid circular shaft consider the loading to have minor shocks. **(16 Marks)**

OR

6 a. A cast iron protected type flange coupling is used to connect two shafts of 80 mm diameter. The shaft runs at 300 rpm and transmits a power of 150 kW. The permissible shear stress for shaft and bolt materials is 50 MPa and permissible shear stress for flange is 10 MPa. design the coupling and draw the sketch. **(08 Marks)**

b. Design a knuckle joint for a tie rod of circular cross section to sustain a maximum tensile load of 75 kN. The material used for the joint has the following permissible stresses: 120 MPa in tension 80 MPa in shear and 180 MPa in crushing. **(08 Marks)**

Module-4

7 a. A double riveted lap joint is to be made between 9 mm plates. If the safe working stresses in tension, crushing and shear are 80,120 and 60 N/mm^2 respectively, design the riveted joint. **(08 Marks)**

b. Determine the diameter of rivet for the joint shown in Fig.Q7(b). The allowable stress in the rivet is 100 N/mm^2. **(08 Marks)**

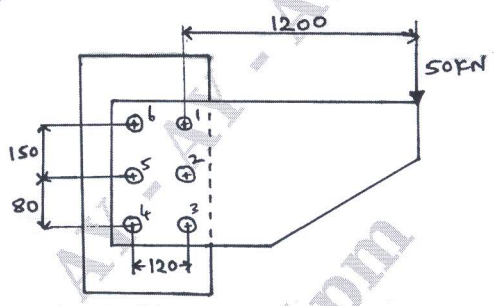

Fig. Q7(b)

OR

8 a. A 16 mm thick plate is welded to a vertical support by two fillet welds as shown in Fig.Q8(a). Determine the size of weld, if the permissible shear stress for the weld material is 75 MPa. **(08 Marks)**

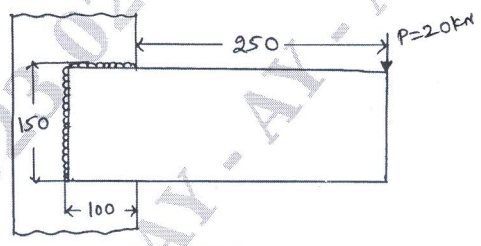

Fig. Q8(a)

b. Determine the allowable stress in the joint shown in Fig.Q8(b), if size of weld is 10 mm.

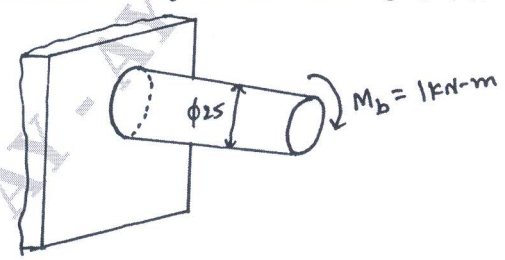

Fig. Q8(b) **(08 Marks)**

Module-5

9 a. A bracket is fixed to the wall by means of four bolts and loaded as shown in Fig.Q9(a). Calculate the size of bolts if the load is 10 kN and allowable shear stress in the bolt material is 40 MPa. **(08 Marks)**

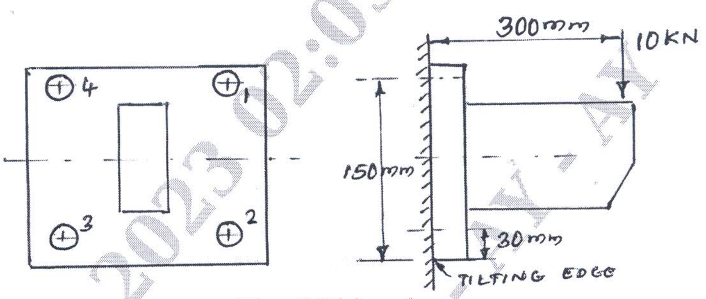

Fig. Q9(a)

b. A square threaded power screw has a nominal diameter of 30 mm and a pitch of 6 mm with double threads. The load on the screw is 6 kN and the mean diameter o f the thrust collar is 40 mm. the coefficient of friction for the screw is 0.1 and the collar is 0.09. Determine :

i) Torque required to raise and lower the screw with load.

ii) Overall efficiency. **(08 Marks)**

OR

10 A screw jack is to lift a load of 80kN through a height of 400mm ultimate strength of screw material in tension and compression is 200 N/mm^2 and in shear 120N/mm^2. The material for the nut is phosphor bronze for which the ultimate strength is 100 N/mm^2 in tension and 90 N/mm^2 in compression and 80 N/mm^2 in shear. The bearing pressure between the nut and the screw is not to exceed 18N/mm^2. Design the screw and nut and check for stresses.

Take FOS = 2 , $\mu = 0.14$. Design jack for 25% overload. **(16 Marks)**

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