CBCS SCHEME

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15ME54

Fifth Semester B.E. Degree Examination, Feb./Mar.2022
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. *Use of design data hand book is allowed.*
3. *Assume any missing data suitably.*

Module-1

1 a. What is mechanical engineering design? Explain. **(04 Marks)**

b. A machine member of diameter 60 mm, in the form of a Cantilever and 300 mm long carries an axial load of 18 KN and a transverse load of 3 KN at its free end. Determine the maximum and minimum principal stresses and maximum shear stresses induced in the member.

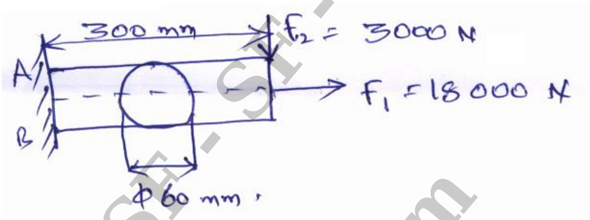

Fig. Q1 (b) **(12 Marks)**

OR

2 a. What is stress concentration? Explain the processes of minimizing the stress concentration. **(06 Marks)**

b. A grooved shaft of 60 mm diameter with semi circular groove of radius 5 mm is made of steel having allowable shear stress of 90 N/mm^2. Determine the power that can be transmitted at 600 rpm. **(10 Marks)**

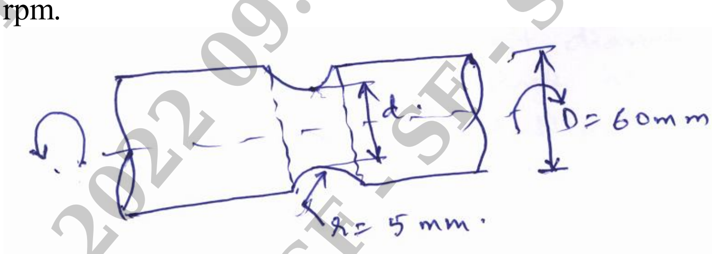

Fig. Q2 (b)

Module-2

3 a. Derive Soderberg equation. **(06 Marks)**

b. A stepped shaft shown in Fig. Q3 (b) has notch sensitivity factor of 0.91. The surface factor of 0.95 and size factor of 0.85. Taking F.O.S as 2, determine the diameter at minimum cross section to sustain a twisting moment that fluctuates between 900 N-mm and 500 N-mm using Soderberg criteria. **(10 Marks)**

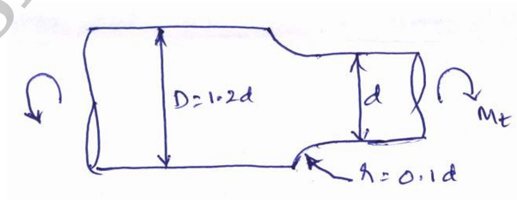

Fig. Q3 (b)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

4 A hot rolled steel shaft is subjected to a torsional load that varies from 330 N-m clockwise to 110 N-m counter clockwise has an applied bending moment that varies from 440 N-m to -220 N-m. The shaft is of uniform cross section and no keyway is present. Determine the required shaft diameter. The material has an ultimate strength of 550 N/mm^2 and a yield strength of 410 N/mm^2. Take F.O.S of 1.5 and endurance limit as half of the ultimate strength. **(16 Marks)**

Module-3

5 A horizontal piece of commercial shaft is supported by two bearings 1.5 m apart. A gear 175 mm diameter is located at 400 mm to the left of right bearing and is driven by another gear directly behind it. A 600 mm diameter pulley is keyed to a shaft 600 mm to the right of left bearing and drives another pulley with horizontal belt. The tension ratio is 3 : 1. The drive transmits 45 at 330 rpm. Take $K_b = K_t = 1.5$. Find the necessary diameter of the shaft and angular deflection. Take allowable stress as 75 MPa in tension and 40 MPa in shear and rigidity modulus as 80 GPa. **(16 Marks)**

OR

6 Design a spigot and socket cotter joint to connect two round rods subjected to a steady load of 120 KN. The material used for the Joint is C40 steel having yield stress of 324 MPa. Taking FOS as 4 in tension and 6 in shear and 3 for crushing. **(16 Marks)**

Module-4

7 Design a double riveted double cover butt joint with equal covers to connect two plates each of 22 mm thickness. The following stresses may be used $\sigma_\theta = 90\,\text{MPa}$, $\tau = 60\,\text{MPa}$ and $\sigma_C = 150\,\text{MPa}$. **(16 Marks)**

OR

8 a. A 16 mm thick plate is welded to 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)**

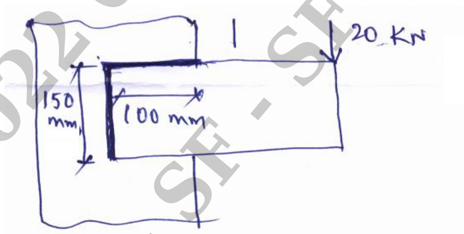

Fig. Q8 (a)

b. Determine the size of the weld for the joint shown in Fig. Q8 (b), if the allowable shear stress in the weld is limited to $80\,\text{N/mm}^2$. **(08 Marks)**

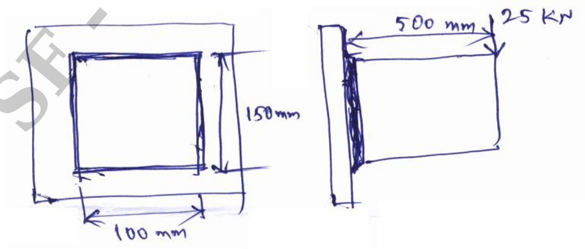

Fig. Q8 (b)

Module-5

9 A cylinder head is fastened to the cylinder of an air compressor using 8 number of bolts. The cylinder core diameter is 300 mm. The pressure inside the cylinder varies from zero to a maximum pressure of 1.5 N/mm^2. The stresses for the bolt material may be taken as $\sigma_u = 500\,N/mm^2$, $\sigma_y = 300\,N/mm^2$ and $\sigma_{-1} = 240$ N/mm^2. The bolts are tightened with an initial preload of 1.5 times the steam load. A copper asbestos gasket is used to make the joint leak proof. Assuming FOS of 2.5 find the size of the bolt required. Neglect stress concentration effect on the bolt and size effect. **(16 Marks)**

OR

10 Design a screw jack completely to lift a load of 45 kN for a lifting height of 320 mm. **(16 Marks)**

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