CBCS SCHEME

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15ME54

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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 handbook is permitted.
3. Assume missing data, if any, suitably.

Module-1

1 a. Briefly explain the process of mechanical engineering design. **(03 Marks)**

b. Explain the importance of standards in design and list different standards used. **(03 Marks)**

c. Determine extreme fiber stresses at section x - x of the machine member loaded as shown in Fig.Q1(c). Also show the distribution of stresses at this section. **(10 Marks)**

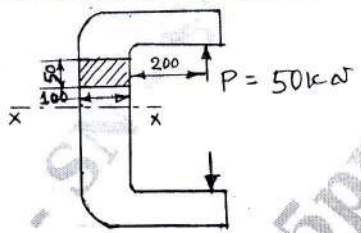

Fig.Q1(c) All dimensions are in mm.

OR

2 a. State and explain following theories of failure:
(i) Maximum normal stress theory
(ii) Maximum shear stress theory **(06 Marks)**

b. A shaft made of C40 steel is subjected to a bending moment of 10 kN-m and a twisting moment of 8 kN-m. Factor of safety used is 2.5. Determine the required diameter of the shaft according to :
(i) Maximum shear stress theory of failure
(ii) Maximum distortion energy theory of failure. **(10 Marks)**

Module-2

3 a. A cantilever beam of span 800 mm has a rectangular cross section of depth 200 mm. The free end of the beam is subjected to a transverse load of 1 kN that drops on to it from a height of 40 mm. Selecting C40 steel (σ_y = 328.6 MPa) and FoS = 3, determine the width of rectangular cross section.

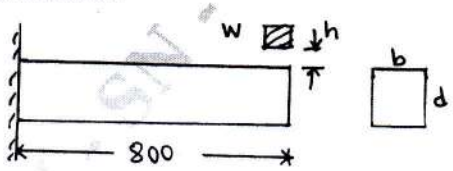

Fig.Q3(a) **(08 Marks)**

b. A rectangular cross section bar 200 mm long is subjected to an impact by a load of 1 kN that falls on to it from a height of 10 mm from rest. Determine the cross section dimension of rectangular bar, if the allowable stress of material of bar is 125 N/mm^2. Assume the thickness depth is twice width. Also find the deformation due to impact. **(08 Marks)**

OR

4 A round rod of diameter 1.2 d is reduced to a diameter 'd' with a fillet radius of 0.1 d. This stepped rod is to sustain a twisting moment that fluctuates between 2.5 kN-m to 1.5 kN-m together with a bending moment of +1 kN-m to −1 kN-m. The rod is made of carbon steel C40 (σ_y = 328.6 MPa; σu = 620 MPa). Determine suitable value for 'd'. **(16 Marks)**

Module-3

5 a. Design a socket and spigot type cotter joint to sustain an axial load of 100 KN. The material selected for the joint has the following design stresses $\sigma_t = 80$ N/mm^2, $\tau = 60$ N/mm^2, $\sigma_c = 150$ N/mm^2. **(08 Marks)**

b. A cast iron 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 bolt material is 50 MPa and permissible shear stress for flange is 8 MPa. Design bolts and the coupling. **(08 Marks)**

OR

6 A shaft mounted between bearings 1.2 m apart receives a power of 20 kW at 1000 rpm through a pulley 600 mm diameter located 400 mm from the left bearing from another pulley directly below it. The power is delivered through a gear of 200 mm diameter located 700 mm from the left bearing to another gear in front of it. The shaft rotates counterclockwise when viewed through the left bearing. The belt has a ratio of tensions of 2.5 and the gear is of 20° pressure angle. Determine the shaft diameter assuming the shaft to be made of steel with an yield shear stress of 180 MPa and factor of safety as 3. Take $K_b = 1.5$, $K_t = 1.0$. **(16 Marks)**

Module-4

7 a. Design a double riveted double strap longitudinal butt joint with unequal straps for a pressure vessel. The ID of the pressure vessel is 1.2 m and vessel is subjected to an internal pressure of 2.5 MPa. The pitch of the rivet in the outer row is to be double the pitch in the inner row. The allowable tensile stress for the plate material is 120 MPa. The allowable shearing and crushing stress for rivet material are : 80 MPa and 170 MPa respectively. The strength of the rivet in double shear is to be taken as 1.875 times that in single shear. Assume efficiency of the joint as 85%. **(08 Marks)**

b. Determine the size of rivets required for the eccentrically loaded joint as shown in Fig.Q7(b). The allowable shear stress for the rivet material is 60 MPa. **(08 Marks)**

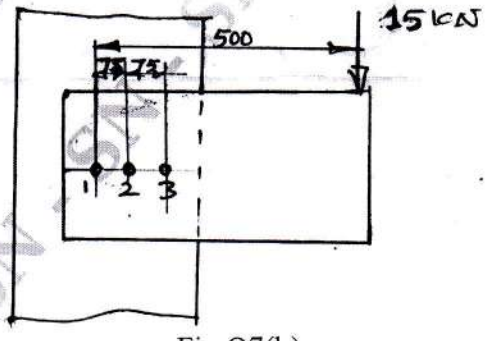

Fig.Q7(b)

OR

8 a. What are the advantages and disadvantages of welded joint over riveted joints? **(03 Marks)**

b. What is a 'Lozange' joint? Where is it used? **(03 Marks)**

c. Determine the size of the weld required for a flat plate welded to a steel column and loaded as shown in Fig.Q8(c). The permissible shear stress for the weld material is 70 MPa. **(10 Marks)**

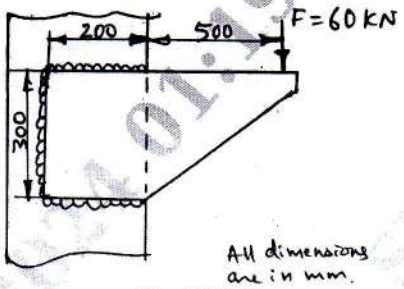

Fig.Q8(c)

Module-5

9 a. The structure in Fig.Q9(a) is subjected to eccentric load P = 10 kN with eccentricity of 500 mm. All holts are identical mode of carbon steel having yield strength in tension is 400 MPa and factor of safety is 2.5. Determine size of bolt.

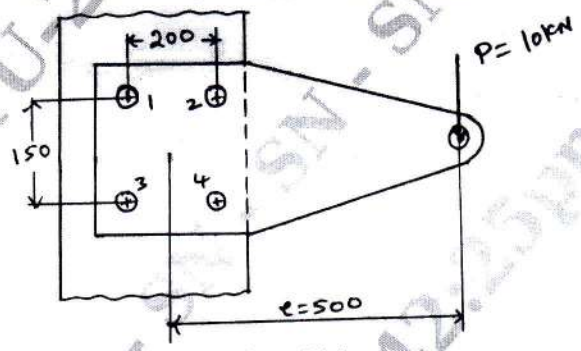

Fig.Q9(a) **(08 Marks)**

b. A bracket is fixed to wall by 4 bolts and loaded as shown in Fig.Q9(b). Calculate the size of bolts if the load is 10 kN and allowable shear stress in bolt material is 40 MPa.

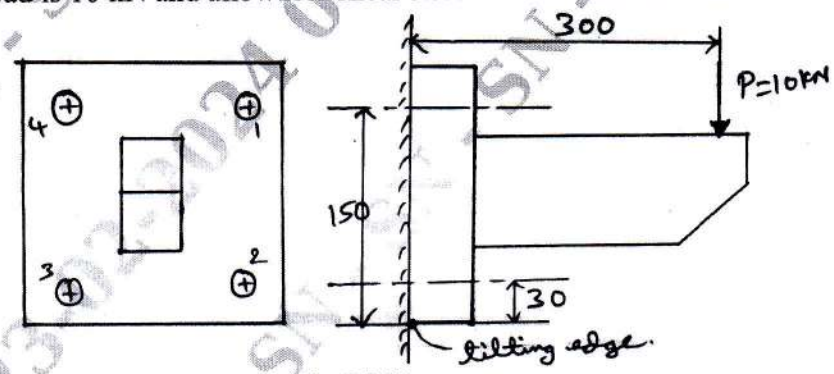

Fig.Q9(b) **(08 Marks)**

OR

10 Design a Screw Jack (complete design) with a lift of 300 mm to lift a load of 50 kN. Select C40 steel (σ_y = 328.6 MPa) for the screw and soft phosphor bronze (σ_{ut} = 345 MPa and σ_y = 138 MPa) for nut. **(16 Marks)**

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