CBCS SCHEME

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18ME52

Fifth Semester B.E. Degree Examination, June/July 2025
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. Assume missing data if any, suitably.
3. Use of Design Data handbook permitted.

Module-1

1 a. Explain the phases of design with a neat block diagram. **(10 Marks)**

b. A point in a structural member subjected to plane stress has $\sigma_x = +40$ MPa, $\sigma_y = (-)30$ MPa, $\tau_{xy} = 25$ MPa. Determine

(i) Normal and tangential stress intensities on the plane inclined at 45°.
(ii) Principal stress and their directions
(iii) Maximum shear stress and the directions of the plane on which they occur. **(10 Marks)**

OR

2 a. List and explain the properties of engineering materials. **(06 Marks)**

b. Find the diameter of the hole for the figure shown in the stress concentration factor at the hole is to be same as at the fillet. **(06 Marks)**

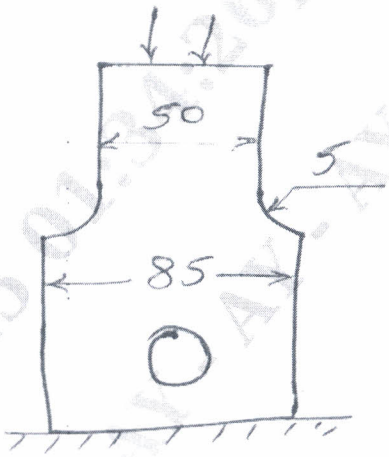

Fig. Q2 (b)

c. A shaft is subjected to axial load of 4 kN, torque of 6 kN-m and bending moment of 3 kN-m at the critical section. Determine the diameter of the shaft considering design stress of shaft material as 100 MPa. **(08 Marks)**

Module-2

3 a. A beam of 300 mm depth 'I' section rests on two supports 5 m apart. It is loaded by a weight of 500 N falling through a height 'h' and striking the beam at midpoint. M.I. of the section is 9.6×10^7 mm^4, $E = 21\times10^4$ N/mm^2. Determine the permissible value of 'h' if the stress is limited to 130 N/mm^2. **(10 Marks)**

b. A SAE 1025 steel rod is subjected to bending moment fluctuating between 200 N-m and 400 N-m. Determine the diameter of rod required considering FoS = 2.5. **(10 Marks)**

OR

4 a. A 450 N weight drops through a height of 25 mm and impacts the center of 250 mm long simply supported square steel beam. If the maximum allowable bending stress is 90 MPa, find the dimensions of the beam and maximum deflection. Take E = 206.8 GPa. **(10 Marks)**

b. The solid circular shaft 15 mm dia is subjected to torsional shear stress that varies from 0 to 35 N/mm^2 and axial stress −15 to +30 N/mm^2. The shaft material has $\sigma_u = 540\,MPa$, $\sigma_y = 400\,MPa$ and $\sigma_{-1} = 200$ MPa. Determine the Factor of Safety. **(10 Marks)**

Module-3

5 A shaft is supported between two bearings 1.5 m apart. A keyed gear 20° involute, 175 mm dia is located 400 mm to the left of right bearing and is driven by a gear directly behind it. A 600 mm dia pulley is keyed to the shaft 600 mm to the right of left bearing and drives a pulley with a horizontal belt directly behind it. The tension ratio of belt is 3 to 1, with slack side on top. The drive transmits 45 KW at 330 rpm. Take $K_b = K_t = 1.5$. Calculate the shaft diameter and angular defelction, using allowable shear stress 40 MPa and $G = 80 \times 10^3$ N/m^2. **(20 Marks)**

OR

6 a. Prove that a square key is equally strong in shear and compression. **(08 Marks)**

b. Design an Rigid flange coupling to transmit 50 KW at 1200 rpm. The permissible shear stress and compressible stress for shaft material are 50 MPa and 100 MPa respectively. **(12 Marks)**

Module-4

7 a. Design a longitudinal welded joint for a 2 m diameter cylinder with a pressure of 1.5 N/mm^2. The allowable tensile stress for the plate material is 80 N/mm^2 and for weld material 90 N/mm^2. The length of the shell is 4 m. **(06 Marks)**

b. A double riveted lap joint (chain type) is to be made of 10 mm plates. Design the riveted joint if the safe working stress in tearing of plates, shear and crushing of rivets are 124 MPa, 93 MPa and 165 MPa respectively. **(14 Marks)**

OR

8 a. A tuple rivetted butt joint with two cover plates of equal width is to be made of 20 mm plates. The allowable stresses in tensile, shear and crushing are 124 MPa, 93 MPa and 165 MPa respectively. The pitch in the outer rows in each plate is twice the pitch of rivets in the inner row. Assume the rivet in double shear are 1.875 times stronger than in single shear. **(12 Marks)**

b. Sketch and explain the types of welded joints. **(08 Marks)**

Module-5

9 a. Design Knuckle joint for an axial load of 80 KN and ultimate stress of 450 MPa. Assume FOS = 4.5. **(10 Marks)**

b. The base of a pillar crane is fastened to the foundation by 12 bolts spaced equally on the bolt circle diameter of 1.6 m. The diameter of the pillar flange is 1.8 m. Determine the size of the bolts when the crane carries a load of 80 kN at a distance of 2 m from the center of the pillar. The allowable stress in the bolt material is 100 MPa. **(06 Marks)**

c. Explain the stresses induced in threaded fastners. **(04 Marks)**

OR

10 a. Design a Cotter joint to resist a load of 40 KN, which acts along the axes of the rods connected by the cotter. The material of the rod and cotter are same having σ_t = 200 MPa, σ_C = 420 MPa and τ = 160 MPa. Assume FOS = 4. **(12 Marks)**

b. Derive expression for torque required to raise load or square threaded screws. **(08 Marks)**

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