CBCS SCHEME

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18ME52

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Use of design data hand book is permitted.

Module-1

1 a. With flow diagram, explain the phases of design. **(05 Marks)**

b. Explain the following :
(i) Bi-axial stress system.
(ii) Tri-axial stress system.
(iii) Principal stresses and Principal plane. **(05 Marks)**

c. At a point in a stressed body, the stresses act are shown in Fig. Q1 (c). Determine the value of
(i) Normal and tangential stress on a plane inclined at 45° with vertical.
(ii) The principal stresses.
(iii) The orientation of principal stresses.
(iv) The max. shear stress and its direction.

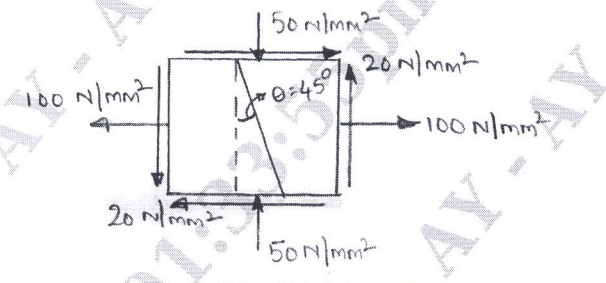

Fig. Q1 (c) **(10 Marks)**

OR

2 a. State and explain following theories of failure :
(i) Max.normal stress theory.
(ii) Max.shear stress theory.
(iii) Distortion energy theory. **(10 Marks)**

b. Find the thickness of a flat bar as shown in Fig.Q2 (b) subjected to axial load of 40 kN. Material has yield stress of 200 MPa. Assume FoS = 2.5.

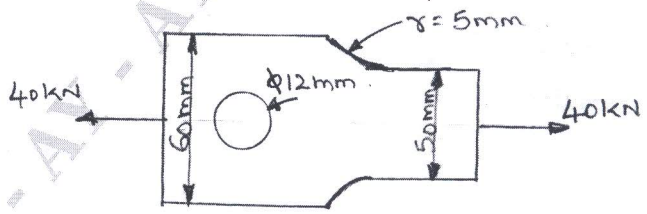

Fig. Q2 (b) **(10 Marks)**

Module-2

3 a. Derive an expression for impact stress induced in a member subjected to axial load. **(10 Marks)**

b. A 5 kg block is dropped from a height of 200 mm onto a beam shown in Fig. Q3 (b). The material has an allowable yield stress of 50 MPa. Determine the dimensions of rectangle section whose depth is 1.5 times the width. Take E = 70 MPa.

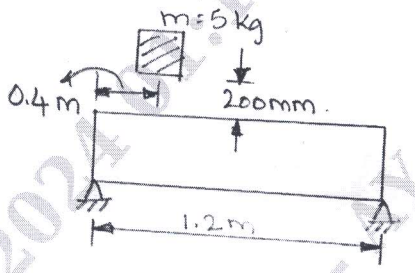

Fig. Q3 (b) **(10 Marks)**

OR

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

b. Determine the max. load for a simply supported beam cyclically loaded as shown in Fig. Q4 (b). The beam material has ultimate strength $\sigma_u = 700$ MPa, yield strength $\sigma_y = 520$ MPa and fatigue strength in reversed bending $\sigma_{-1} = 320$ MPa. Use FoS = 1.25. The load, size and surface correction factors are 1, 0.75 and 0.9 respectively.

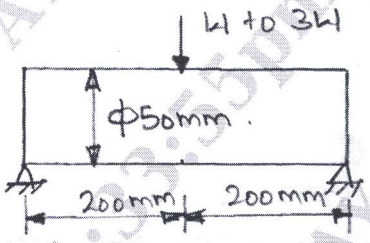

Fig. Q4 (b) **(14 Marks)**

Module-3

5 A shaft is supported by two bearing placed 1100 mm a part. A pulley of diameter 620 mm is keyed at 400 mm to the right from the left hand bearing and this drives a pulley directly below it with a max. tension of 2.75 kN. Another pulley of diameter 400 mm is placed 200 mm to the left of right hand bearing and is driven with a motor placed horizontally to the right. The angle of contact of the pulleys is 180° and $\mu = 0.3$. Find the diameter of the shaft. Assume $C_m = 3.0$, $C_t = 2.5$, $\sigma_y = 190$ MPa and $\sigma_{ut} = 300$ MPa. **(20 Marks)**

OR

6 a. Find the dimensions of the steel tapered key to transmit 20 kW at 1800 rpm. Allowable shear and compressive stresses are 80 MPa and 170 MPa respectively. Also calculate the axial force required to drive the key. **(10 Marks)**

b. Design a flange coupling to connect a shaft to a motor with following specifications. Take pump output 3000 litres/min, total head 20 m, pump speed = 600 rpm, $\eta = 70\%$. Select C-40 steel (Allowable shear stress = 82.15 MPa) for shaft, C-35 for key (Allowable shear stress = 76 MPa). Assume allowable shear stress in cast iron flange is 15 MPa. **(10 Marks)**

Module-4

7 a. With a neat sketch, Caulking and Fullering. **(10 Marks)**

b. An eccentrically loaded weld is as shown in Fig. Q7 (b). Determine the size of the weld required.

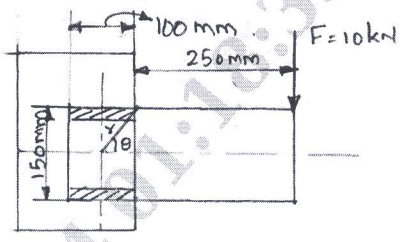

Fig.Q7 (b) **(10 Marks)**

OR

8 a. Design a double riveted-double row chain riveting with equal width cover plates, with butt joint with 2 cover plates for the longitudinal seam of a boiler shell, 1.5 m diameter subjected to a steam pressure of 0.95 N/mm^2. Assume required efficiency of 75%, take allowable tensile stress in plate as 90 N/mm^2, allowable compressive stress is 140 N/mm^2, allowable shear stress is 56 N/mm^2. **(10 Marks)**

b. A bracket supporting load P is welded to a plate by a four fillet welds of size 6 mm. What is the max. load that may be carried by the joint shown in Fig. Q8 (b) if the stress in the joint is 96 MPa.

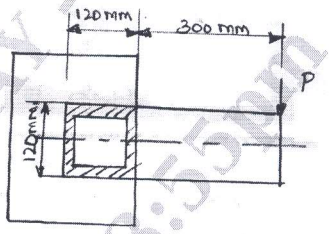

Fig. Q8 (b) **(10 Marks)**

Module-5

9 a. Design a socket and spigot cotter joint to connect two rods subjected to a tensile load of 120 kN, the permissible stresses for joint may be taken as 100 MPa in tension, 60 MPa in shear and 120 MPa in crushing. **(10 Marks)**

b. Derive an expression for torque required to raise the load for square threaded screw with usual notations. **(10 Marks)**

OR

10 a. Design a knuckle joint for a tie rod of circular cross section to sustain a max. pull of 70 kN, the ultimate tensile strength of a rod is 450 MPa, the ultimate crushing and shear strength of the pin material is 510 MPa and 396 MPa respectively. Take FoS = 6. **(10 Marks)**

b. A weight of 250 kN is raised at a speed of 6 m/min by two screw rods with square threads of 50×8 mm cut on them. Determine

(i) Torque required to raise the load.
(ii) Speed of rotation of screw rod assuming the threads of double start.
(iii) Max. stress induced on the cross section of the screw rod.
(iv) Efficiency of screw drive.
(v) Length of the nut for the purpose of supporting the load.
(vi) Check for overhaul. Take allowable bending pressure in nut and screw is $\sigma'_b = 15$ MPa. **(10 Marks)**

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