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15AU53

Fifth Semester B.E. Degree Examination, Jan./Feb. 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.Use of Design Data Hand book is permitted.
3.Assume any missing data suitably.

Module-1

1   a. Define codes and standards used in design. **(04 Marks)**
    b. Define Factor of Safety. **(02 Marks)**
    c. A 50mm diameter steel rod supports a load of 9 kN and in addition is subjected to torsional moment of 100 N-m. Determine the maximum tensile and maximum shear stress. [Refer Fig.Q1(c)]
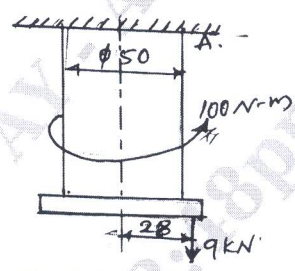

Fig.Q1(c) **(10 Marks)**

OR

2   a. State and explain the following theories of failure :
    (i) Maximum Normal Stress Theory   (ii) Maximum Shear Stress Theory. **(06 Marks)**
    b. A bolt is subjected to a direct tensile load of 30 kN and a transverse shear force of 15 kN. Material of bolt has yield strength of 360 MPa, with Poisson's ratio of 0.25 and factor of safety as 3. Determine the diameter of bolt according to
    (i) Maximum Normal Stress Theory   (ii) Maximum Shear Stress Theory. **(10 Marks)**

Module-2

3   a. Determine the thickness of rectangular plate as shown in Fig.Q3(a). The maximum stress in the plate is 130 MPa. Take stress concentration into account.
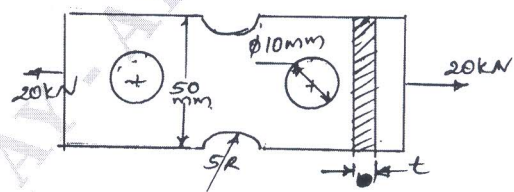

Fig.Q3(a) **(06 Marks)**

    b. A rectangular cross section bar 200mm long is subjected to an impact load of 1 kN falls from a height of 10mm from rest. Determine the dimensions of bar if allowable stress of material is 125 N/mm^2. Assume the width is twice the thickness. Take E = 206 GPa. **(10 Marks)**

OR

4   A cantilever beam is subjected to load varies from F to 3F as shown in Fig.Q4. Determine the maximum load at this member can withstand for an indefinite life. The material of beam has σ_u = 550 MPa, σ_y = 470 MPa, σ_{en} = 275 MPa, k_t = 1.42, FOS = 2, Notch sensitivity is 0.9.
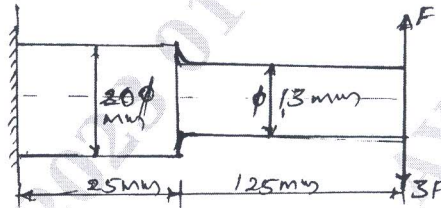

Fig.Q4   **(16 Marks)**

Module-3

5   a.   Design a CI flanged coupling for a steel shaft transmitting 18 kW at 1440 rpm. The allowable shear stress and crushing stress for steel is 40 MPa and 80 MPa respectively. The allowable shear stress in CI flange is 10 MPa.   **(10 Marks)**

b.   Design a knuckle joint to sustain an axial load of 40 kN. The material selected for the joint has the following design stresses. σ_t = 100 MPa , σ_c = 120 MPa and τ = 55 MPa.   **(06 Marks)**

OR

6   A solid steel shaft running at 600 rpm is supported on bearings 600mm apart. The shaft receives 40 kW through a 400 mm diameter pulley weighing 400 N located 300mm to the right of left bearing, by the vertical belt drive. The power transmitted from the shaft through another pulley of diameter 600mm weighing 600 N located 200mm to the right of right bearing. The belt drives are at right angles to each other and ratio of belt tensions is 3. Determine the size shaft if the allowable shear stress in the shaft material is 40 MPa.

(16 Marks)

Module-4

7   a.   A plate of 80mm wide and 15mm thick is to be joined with another plate by a single transverse weld and double parallel weld. Determine the length of weld if the joint is subjected to both static and fatigue loading. Take σ_t = 90 MPa and τ = 55 MPa and stress concentration factors 1.5 for transverse weld and 2.7 for parallel weld.   **(08 Marks)**

b.   Determine the size of weld for a welded joint loaded as shown in Fig.Q7(b). The permissible shear stress for the weld material is 95 MPa.
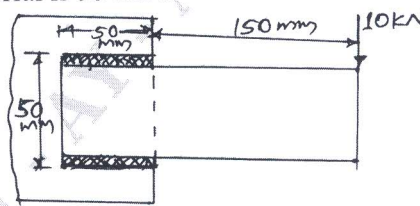

Fig.Q7(b)   **(08 Marks)**

OR

8   a.   Explain the failure of Riveted joints.   **(06 Marks)**

b.   A triple riveted lap joint is to be made of between 15mm plates. If the safe working stresses in tensile crashing and shear are 120, 160 and 90 MPa respectively. Design the riveted joint, if the pitch in the outermost row is twice the pitch of rivets in the inner row.   **(10 Marks)**

Module-5

9 a. The cylinder head of a reciprocating air compressor is held in place by 10 bolts. The total joint stiffness is 4 times the total bolt thickness. The initial tension in each bolt is 5 kN. The total external force acting to separate the joint is 20 kN. Find the size of bolt if the stress in bolt is 100 MPa. **(08 Marks)**

   b. The structure as shown in Fig.Q9(b) is subjected to eccentric load of 10 kN with eccentricity of 500 mm. All bolts are identical and having stress in tension of 160 MPa. Determine the size of bolt.
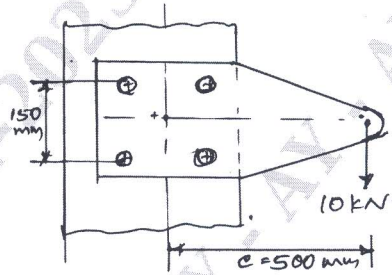

Fig.Q9(b) **(08 Marks)**

OR

10 a. Derive condition for self locking of square thread with collar friction. **(04 Marks)**

   b. A single start square threaded power screw is used to rise a load of 120 kN. The screw has mean diameter of 24mm and 4 threads per 24 mm length. The mean collar diameter is 40mm. The coefficient of friction is estimated as 0.1 for both thread and collar. Determine
   (i)   The major diameter of screw
   (ii) Torque required to raise the load
   (iii) Overall efficiency

   (12 Marks)

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