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17ME54

Fifth Semester B.E. Degree Examination, July/August 2021
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions.
2. Any missing data may be suitably assumed.
3. Use of design data handbook is permitted.

1 a. What is Mechanical Engineering Design? Explain the steps involved in design with a block diagram. **(08 Marks)**

b. A circular rod of diameter 50mm is subjected to loads as shown in Fig.Q1(b). Determine the nature and magnitude of stresses at the critical points. **(12 Marks)**

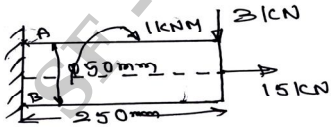

Fig.Q1(b)

2 a. What is stress concentration? Explain the factors affecting the stress concentration. **(04 Marks)**

b. State and explain the theories of failure applicable to (i) ductile (ii) brittle material. **(04 Marks)**

c. Determine the maximum stress induced in the semi circular grooved shaft shown in Fig.Q2(c), if it is subjected to (i) An axial load of 40 kN (ii) A bending moment of 400 N-m (iii) A Twisting moment of 500 N-m. Take the stress concentration into account.

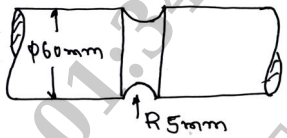

Fig.Q2(c) **(12 Marks)**

3 a. Derive an expression for stress induced in a rod due to the axial impact of a weight 'W' dropped from a height 'h' on to a collar attached at the free end of the rod. What is the stress due to suddenly applied load? **(08 Marks)**

b. A cantilever beam of span 800 mm has a rectangular cross-section of depth 200mm. The free end of the beam is subjected to a transverse load of 1 kN that drops on to it from a height of 40mm. Selecting C-40 steel (σ_y = 328.6 MPa) and factor of safety = 3, determine the width of rectangular cross section. **(12 Marks)**

4 a. Derive Soderberg's relation for a member subjected to fatigue loading. **(05 Marks)**

b. Determine the maximum load for the simply supported beam, cyclically loaded as shown in Fig.Q4(b). The ultimate strength is 700 MPa. The yield point in tension is 520 MPa and the endurance limit is reversed bending is 320 MPa. Use a factor of safety of 1.25. The load, size and surface correction factors are 1, 0.75 and 0.9 respectively. **(15 Marks)**

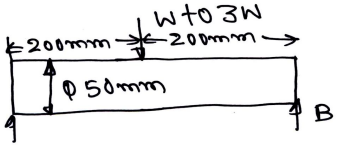

Fig.Q4(b)

5 A horizontal piece of commercial shafting is supported by two bearings 1.5m apart. A keyed gear 20° involute and 175 mm in diameter is located 400mm to the left of the right bearing and is driven by a gear directly behind it. A 600 mm diameter pulley is keyed to the shaft 600 mm to the right of the left bearing and drives a pulley with a horizontal belt directly behind it. The tension ratio of the belt is 3 to 1, with the slack side on top. The drive transmits 45 kW at 330 rpm. Take $k_b = k_t = 1.5$. Calculate the necessary diameter of the shaft and angular deflection in degrees. Use allowable shear stress 40 MPa and $G = 80\times10^9$ N/mm^2. **(20 Marks)**

6 a. Design a Knuckle joint to transmit 150 kN. The design stress may be taken as 75 N/mm^2 in tension, 60 N/mm^2 in shear and 150 N/mm^2 in compression. **(10 Marks)**

b. Design a protected type cast iron flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted to be 20% greater than the full load torque. The allowable shear stress in the bolt is 60 MPa and the allowable shear stress in the flange is 40 MPa. **(10 Marks)**

7 a. Design a triple riveted lap joint zig-zag type, for a pressure vessel of 1.5 M diameter. The maximum pressure inside the vessel is 1.5 MPa. The allowable stresses in tension, crushing and shear are 100, 125 and 75 MPa respectively. **(10 Marks)**

b. Determine the diameter of rivet for the joint shown in Fig.Q7(b). The allowable stress in the rivets is 100 N/mm^2.

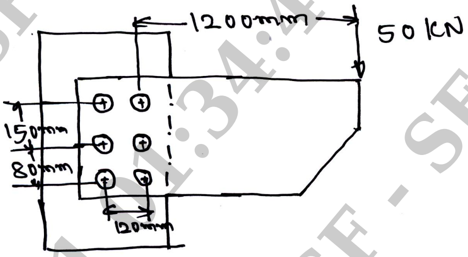

Fig.Q7(b) **(10 Marks)**

8 a. A plate of 80 mm wide and 15 mm thick is joined with another plate by a single transverse weld and a double parallel weld. Determine the length of parallel fillet weld if the joint is subjected to both static and fatigue loading. Take σ_t = 90 MPa, τ = 55 MPa as the allowable stresses and stress concentration factors as 1.5 for transverse and 2.7 for parallel weld. **(10 Marks)**

b. A 16 mm thick plate is welded to a vertical support by two fillet welds shown in Fig.Q8(b). Determine the size of weld, if the permissible shear stress for the weld material is 75 MPa.

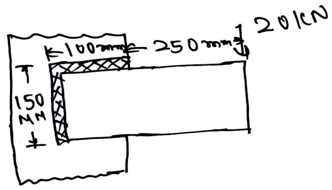

Fig.Q8(b) **(10 Marks)**

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

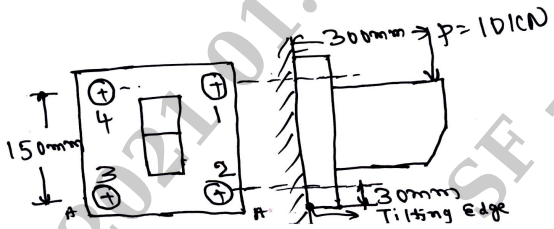

Fig.Q9(a) **(10 Marks)**

b. The structural connection shown in Fig.Q9(b) is subjected to an eccentric load P of 10 kN with an eccentricity of 500mm. The centre distance between bolts at 1 and 3 is 150mm and the centre distance between bolts 1 and 2 is 200mm. All the bolts are identical. The bolts are made of plain carbon steel having yield strength in tension of 400 MPa and the F.O.S is 2.5. Determine size of bolts. **(10 Marks)**

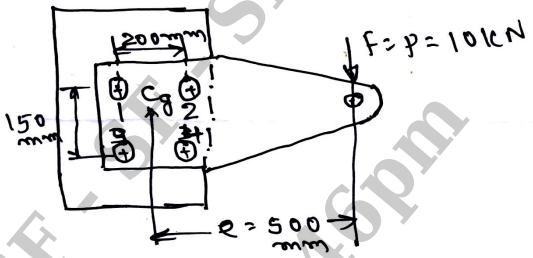

Fig.Q9(b)

10 a. Explain self locking and overhauling in power screws. **(05 Marks)**

b. A square threaded power screw has a nominal diameter of 30mm and a pitch of 6mm with double threads. The load on the screw is 6 kN and the mean diameter of the thrust collar is 40mm. The C.O.F for the screw is 0.1 and the collar is 0.09. Determine

(i) Torque required to raise the screw against load.
(ii) Torque required to lower the screw with the load.
(iii) Overall efficiency
(iv) Is this screw self-locking. **(15 Marks)**

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