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## 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. Use of data hand book is permitted.  
3. Missing data should be suitably assumed and clearly stated.

- 1 a. Write brief note on general procedure used in design. (06 Marks)
- b. List the factors which govern the selection of a material for a machine component. (04 Marks)
- c. A circular rod of diameter 50 mm is subjected to loads as shown in Fig. Q1 (c). Determine the nature and magnitude of stresses at critical points 'A' and 'B'. (10 Marks)

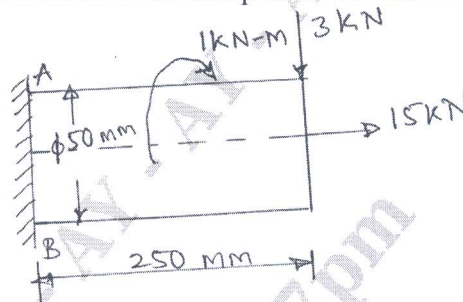


Fig. Q1 (c)

- 2 a. A mild steel shaft is subjected to 3500 N-m of bending moment at its critical point and transmits a torque of 2500 N-m. The shaft is made of steel having yield strength of 231 MPa. Estimate the size of the shaft based on the following theories of failure:
  - (i) Maximum normal stress theory.
  - (ii) Maximum shear stress theory.
 Take FOS = 2. (10 Marks)
- b. A rectangular plate with semi-circular groove of radius 12 mm as shown in Fig. Q2 (b) is subjected to, (i) Tensile force of 10 kN (ii) Bending moment of 15 N-m. Determine the maximum stress induced in each case. (10 Marks)

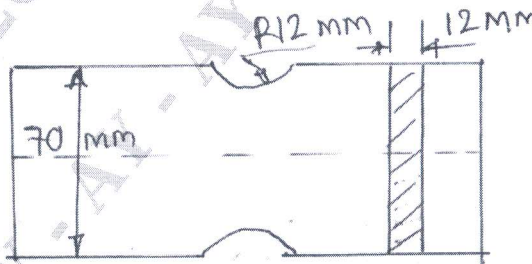


Fig. Q2 (b)

- 3 a. Derive an expression for impact stresses due to axial load. (10 Marks)
- b. A rough finished steel rod having  $\sigma_U = 620$  MPa,  $\sigma_y = 400$  MPa and  $\sigma_{-1} = 345$  MPa is subjected to completely reversed bending moment of 400 N-m. Determine the diameter of the rod required based on factor of safety of 2.5. (10 Marks)

- 4 a. Define endurance limit. List the factors affecting endurance limit. Explain any one factor. (06 Marks)
- b. A steel member of circular cross-section is subjected to a torsional stress that varies from 0 to 35 MPa and at the same time it is subjected to an axial stress that varies from  $-14$  MPa to  $+28$  MPa. Neglecting stress concentration and column effect and assuming that the maximum stresses in torsion and axial load occur at the same time. Determine
- The maximum equivalent shear stress.
  - The design factor of safety based on yield in shear
- The material has an endurance limit  $\sigma_{-1} = 206$  MPa and a yield strength of  $\sigma_y = 480$  MPa. The diameter of the member is less than 12 mm. Take load concentration factor = 1, surface finish factor is equal to 1. (14 Marks)
- 5 A horizontal piece of commercial shafting is supported by two bearings 1.5 m apart. A keyed gear  $20^\circ$  involute and 175 mm in diameter is located 400 mm to the left of 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 : 1, with slack side on top. The drive transmits 45 kW at 330 rpm. Take  $C_M = C_t = 1.5$ . Calculate the necessary shaft diameter and angular deflection in degrees. Use allowable shear stress of 40 MPa and  $G = 80$  GPa. (20 Marks)
- 6 a. Find the length of square key of size  $\frac{d}{4}$  such that the shaft and the key are made up of same material. (06 Marks)
- b. Design a protective CI flange coupling for a steel shaft transmitting 15 kW at 200 rpm and having an allowable shear stress of 40 MPa. The working stress in the bolt should not exceed 30 MPa. Assume that the same material is used for shaft and key and the existing stress is twice its value in shear stress. The maximum torque is 25% greater than the full load torque. The shear stress for CI is 14 MPa. (14 Marks)
- 7 a. Design a double riveted butt joint with two cover plates for the longitudinal beam of a boiler shell 1.5 m in diameter subjected to a steam pressure of  $0.95$  N/mm<sup>2</sup>. Assume an efficiency of 75% allowable tensile stress in the plate of 90 MPa allowable compressive stress of 140 MPa and an allowable shear stress in the rivets as 56 MPa (Assume chain riveting). (10 Marks)
- b. For the riveted joint shown in Fig. Q7 (b), determine the size of the rivet taking permissible shear stress in rivets as 60 MPa. (10 Marks)

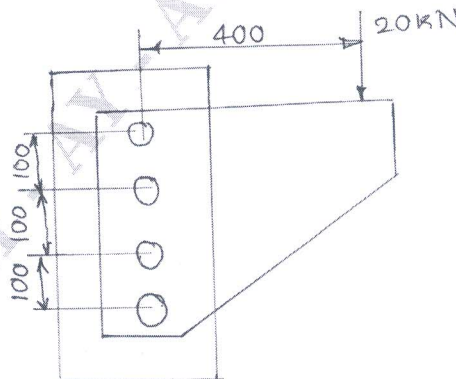


Fig. Q7 (b)

- 8 a. A 80 mm wide, 12 mm thick plate carrying an axial load of 96 kN is welded to a support as shown in Fig. Q8 (a). The following tensile and shear stress in the weld are 100 MPa and 70 MPa respectively. Find the length of each parallel fillet weld. (10 Marks)

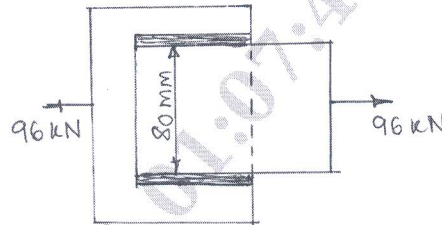


Fig. Q8 (a)

- b. A shaft of rectangular cross section is welded to a support by means of fillet welds as shown in Fig. Q8 (b). Determine the size of the welds, if permissible shear stress in the weld is limited to 75 MPa. (10 Marks)

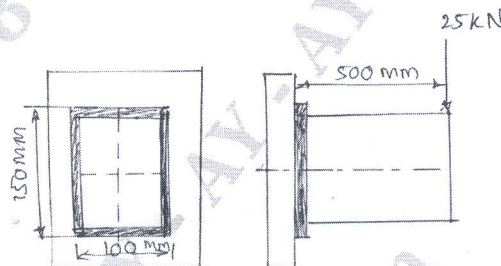


Fig. Q8 (b)

- 9 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.  $\sigma_t = 100$  MPa,  $\sigma_c = 150$  MPa and  $\tau = 60$  MPa. (10 Marks)
- b. A M20  $\times$  2 steel bolt of 100 mm is subjected to impact load. The energy absorbed by the bolt is 2 N-m.
- Determine the stress in the shank of the bolt. If there is no thread portion between the nut and bolt head.
  - Determine the stress in the shank, if the entire length of the bolt is threaded. Assume modulus of elasticity for steel as 206 GPa. (10 Marks)
- 10 a. What is self locking of a power screw? Derive an equation for torque required to raise the load on a square thread. (10 Marks)
- b. The lead screw of a machine has single start trapezoidal threads of 30 mm outside diameter and 6 mm pitch. It drives the tool carriage against an axial load of 1500 N. The thrust collar has a mean diameter of 40 mm. The carriage is moved at a speed of 0.72 m/sec. The co-efficient of friction for both screw and collar is 0.14. Find the power required to drive the screw and the efficiency. (10 Marks)

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