

Fifth Semester B.E. Degree Examination, Aug./Sept.2020

**Design of Machine Elements – I**

Time: 3 hrs.

Max. Marks:100

- Note: 1. Answer any FIVE full questions, selecting at least TWO questions from each part.  
 2. Use of design data handbook is permitted.  
 3. Missing data, if any, may be suitably assumed.

**PART – A**

- 1 a. Write brief note on general procedure used in design. (06 Marks)  
 b. Explain mechanical properties of materials. (04 Marks)  
 c. A point in a structural member subjected to plane stress is shown in the Fig.Q1(c). Determine the following :  
 (i) Normal and tangential stress intensities on plane MN inclined at an angle of 45°.  
 (ii) Principal stresses and their direction.  
 (iii) Maximum shear stress and the direction of the planes on which it occurs.

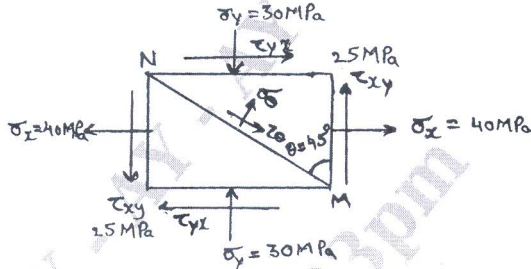


Fig.Q1(c) (10 Marks)

- 2 a. Define factor of safety and discuss factors influencing selection of appropriate value for the factor of safety. (04 Marks)  
 b. Explain the theories of failure. (06 Marks)  
 c. A circular rod of 60 mm diameter is subjected to loads as shown in Fig.Q2(c). Determine the nature and magnitude of stresses at the critical points.

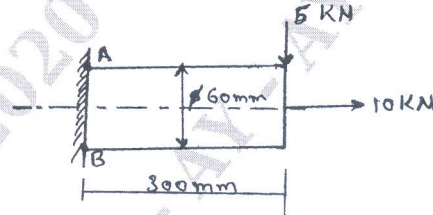


Fig.Q2(c) (10 Marks)

- 3 A ground steel cantilever member shown in Fig.Q3 is subjected to a transverse load at its free end that varies from 100 N up and 200 N down and an axial load varies from 500 N compression to 1000 N tension. Determine the required diameter of the section using a factor of safety 2. The strength properties of the materials are  $\sigma_u = 550$  MPa,  $\sigma_y = 480$  MPa and  $\sigma_c = 270$  MPa, Notch sensitively is 0.9.

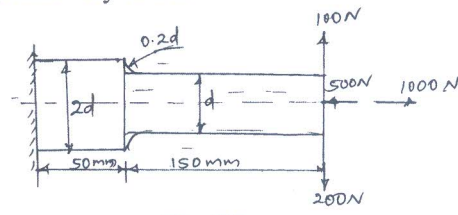


Fig.Q3 (20 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
 2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

- 4 a. The cylinder head of a reciprocating air compressor is held in place by ten bolts. The total joint stiffness is four times the total bolt stiffness. Each bolt is tightened to an initial tension of 5 kN. The total external force acting to separate the joint is 20 kN. Find the size of the bolts so that the stress in bolts is not exceed 100 MPa. (08 Marks)
- b. A radial drilling machine with circular base is mounted to a base plate by means of three steel bolts equally spaced on a bolt circle diameter of 0.3 m. The diameter of the circular base is 0.4 m. The spindle is positioned at a radial distance of 0.335 m from the centre of the column. During drilling operation, the spindle is subjected to a force of 4.5 kN. Determine the size of the bolts if the allowable stress in bolt material is 100 MPa. (12 Marks)

## PART - B

- 5 A shaft is supported between two bearings located 0.6 m apart. Gear 'A' of pitch circle diameter 0.1 m is keyed to the shaft 0.1 m to the right of the left bearing. Gear 'B' of 0.15 m diameter keyed to the shaft 0.3 m to the right of the left bearing. Another gear 'C' of pitch circle diameter 0.08 m is keyed to the shaft 0.1 m to the left of the right bearing. Gear 'B' receives 10 kW power at 500 rpm from a mating gear mounted directly below it. Gear 'A' delivers 6 kW power to another gear mounted directly in front of it, such that the tangential force act vertically upwards. The gear 'C' delivers the remaining power to its mating gear mounted directly behind it, such that the tangential force acts vertically downwards. All gears are of 20° full depth involute form. The shaft is made up of steel which has an ultimate strength of 510 MPa and yield strength of 330 MPa. Determine the required diameter of the shaft under steady load condition using ASME code. (20 Marks)
- 6 a. Explain screw thread terminology. What are its uses? (06 Marks)
- b. A cylinder head is fastened to the cylinder of an air compressor using 8 number of bolt. The cylinder core diameter is 300 mm. The pressure inside the cylinder varies from zero to a maximum pressure of 1.5 N/mm<sup>2</sup>. The stresses of the bolt material may be taken as  $\sigma_u = 500$  N/mm<sup>2</sup>,  $\sigma_y = 300$  N/mm<sup>2</sup> and  $\sigma_{-1} = 240$  N/mm<sup>2</sup>. The bolts are tightened with an initial preload of 1.5 times the steam load, A copper asbestos gasket is used to make the joint leak proof. Assuming a FOS – 2.5 find the size of bolt required. Neglect stress concentration affect on the bolt and size effect. (14 Marks)
- 7 a. Design a triple riveted lap joint with zig-zag riveting for steel plates 20 mm thick using  $\sigma_t = 90$  N/mm<sup>2</sup>,  $\sigma_c = 120$  N/mm<sup>2</sup> and  $\tau = 60$  N/mm<sup>2</sup>. (10 Marks)
- b. Design the longitudinal joint for a boiler of diameter 2 m taking the permissible pressure as 2.5 MPa. Assume the tensile, shear and compressive stresses for the materials of shell and rivets as 90 MPa, 60 MPa and 120 MPa respectively. (10 Marks)
- 8 a. A steel plate welded by fillet welds to a structure is loaded as shown in Fig. Q8 (a). Calculate the size of weld if the load is 35 kN and allowable shear stress for the weld material is 90 MPa.

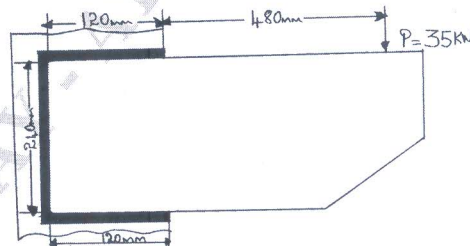


Fig. Q8 (a)

- (12 Marks)
- b. A power screw for a jack has square threads of proportion 50×42×8, while the coefficient of friction at the threads is 0.1 and that of collar is 0.12. Determine the weight that can be lifted by the jack through an effort of 400 N applied through a hand lever of span 400 mm. (08 Marks)