

**BT-5/D-21**  
**MACHINE DESIGN-I**  
**Paper–ME-309N**

**45128**

Time Allowed : 3 Hours]

[Maximum Marks : 75

**Note :** Attempt **five** questions in all, selecting at least **one** question from each Unit. All questions carry equal marks. Assume any missing data suitably.

**UNIT-I**

1. (a) Explain the general considerations in machine design. 5
- (b) What are the factors which should be taken into account while selecting a material for any engineering application? 5
- (c) How is grey cast iron designated in Indian standards? 5
2. (a) The stresses induced at a critical point in a machine component made of steel 45C8 ( $S_{yt}=380 \text{ N/mm}^2$ ) are as follows:  $\sigma_x=100 \text{ N/mm}^2$ ,  $\sigma_y=40 \text{ N/mm}^2$ ,  $\tau_{xy}=80 \text{ N/mm}^2$ . Calculate the factor of safety by (i) the maximum normal stress theory, (ii) the maximum shear stress theory, and (iii) the distortion energy theory. 8
- (b) A solid circular shaft, 15 mm in diameter, is subjected to torsional shear stress, which varies from 0 to  $35 \text{ N/mm}^2$  and at the same time, is subjected to an axial stress that varies from  $-15$  to  $+30 \text{ N/mm}^2$ . The frequency of variation of these stresses is equal to the shaft speed. The shaft is made of steel FeE 400 ( $S_{ut} = 540 \text{ N/mm}^2$  and  $S_{yt} = 400 \text{ N/mm}^2$ ) and the corrected endurance limit of the shaft is  $200 \text{ N/mm}^2$ . Determine the factor of safety. 7

**UNIT- II**

3. A bolted joint is used to connect two components. The combined stiffness of the two components is twice the stiffness of the bolt. The initial tightening of the nut results in a preload of 10 kN in the bolt. The external

force of 7.5 kN creates further tension in the bolt. The bolt is made of plain carbon steel 30C8 ( $S_{yt} = 400 \text{ N/mm}^2$ ) and the factor of safety is 3. There are coarse threads on the bolt. Calculate the tensile stress area of the bolt and specify a suitable size for the bolt. 15

4. A welded connection of steel plates is shown in Fig. 1. It is subjected to an eccentric force of 50 kN. Determine the size of the weld, if the permissible shear stress in the weld is not to exceed  $70 \text{ N/mm}^2$ . 15

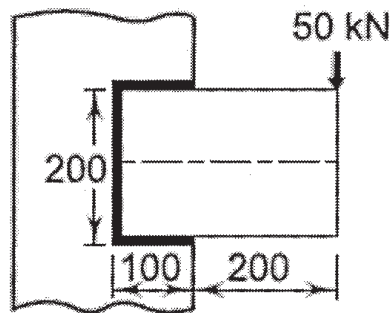


Fig. 1

### UNIT-III

5. A propeller shaft is required to transmit 50 kW power at 600 rpm. It is a hollow shaft, having an inside diameter 0.8 times of the outside diameter. It is made of steel ( $S_{yt} = 380 \text{ N/mm}^2$ ) and the factor of safety is 4. Calculate the inside and outside diameters of the shaft. Assume ( $S_{sy} = 0.5S_{yt}$ ) 15
6. Design a right angled bell crank lever having one arm 500 mm and the other 150 mm long. The load of 5 kN is to be raised acting on a pin at the end of 500 mm arm and the effort is applied at the end of 150 mm arm. The lever consists of steel forgings, turning on a point at the fulcrum. The permissible stresses for the pin and lever are 84 MPa in tension and compression and 70 MPa in shear. The bearing pressure on the pin is not to exceed  $10 \text{ N/mm}^2$ . 15

### UNIT-IV

7. A rigid coupling is used to connect a 45 kW, 1440 rpm electric motor to a centrifugal pump. The starting torque of the motor is 225% of the rated torque. There are 8 bolts and their pitch circle diameter is 150 mm. The

bolts are made of steel 45C8 ( $S_{yt} = 380 \text{ N/mm}^2$ ) and the factor of safety is 2.5. Determine the diameter of the bolts. Assume ( $S_{sy} = 0.577S_{yt}$ ) Assume that the bolts are finger tight in reamed and ground holes. 15

8. A cast iron pipe is to carry  $60 \text{ m}^3$  of compressed air per minute at a pressure of  $1 \text{ N/mm}^2$ . The velocity of air in the pipe is limited to  $10 \text{ m/s}$  and the permissible tensile stress for the material of the pipe is  $14 \text{ MPa}$ . Find the diameter of the pipe and its wall thickness. 15

