

Name :

Roll No. :

Invigilator's Signature :

**CS/B. TECH (ME / PE) / SEM-5 / ME-503 / 2010-11
2010-11**

DESIGN OF MACHINE ELEMENTS

Time Allotted : 6 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

$$10 \times 1 = 10$$

- i) A stud
- a) has a head on one end and a nut fitted to the other
 - b) has head at one end and other end fits into a tapped hole in the other part to be joined
 - c) has both ends threaded
 - d) has pointed threads.

CS/B. TECH (ME / PE) / SEM-5 / ME-503 / 2010-11

- ii) According to Lamé's equation, the thickness of a cylinder is

a) $r_i \left[\sqrt{\frac{\sigma_t + (1 - 2\mu)p}{\sigma_t - (1 - 2\mu)p}} - 1 \right]$ b) $r_i \left[\sqrt{\frac{\sigma_t + (1 - \mu)p}{\sigma_t - (1 - \mu)p}} - 1 \right]$

c) $r_i \left[\sqrt{\frac{\sigma_t + p}{\sigma_t - p}} - 1 \right]$ d) $r_i \left[\sqrt{\frac{\sigma_t}{\sigma_t - 2p}} - 1 \right]$

- iii) Tie rods are load carrying members which carry

- a) tensile loads b) compressive loads
c) transverse loads d) torsion loads.

- iv) The centrifugal tension in belts

- a) reduces power transmission
b) increases power transmission
c) does not effect power transmission
d) increases power transmission up to certain speed and then decreases.

CS/B. TECH (ME / PE) / SEM-5 / ME-503 / 2010-11

- v) The parallel fillet welded joint is designed for
- a) tensile strength b) bending strength
 - c) compressive strength d) shear strength.
- vi) A basic shaft is one whose
- a) lower deviation is zero
 - b) lower and upper deviations are zero
 - c) upper deviation is zero
 - d) none of these.
- vii) In transmission of compressive load from one rod to another in a cotter joint takes place
- a) directly b) via cotter
 - c) via cotter pin d) via collar.

CS/B. TECH (ME / PE) / SEM-5 / ME-503 / 2010-11

viii) Spring index is

- a) ratio of coil diameter to wire diameter
- b) load required to produce unit deflection
- c) its capability of storing energy
- d) indication of quality of spring.

ix) Creep in belt drive is due to

- a) material of the belt
- b) material of the pulley
- c) uneven tension and contraction due to varying tension
- d) expansion of the belt.

x) The square thread is usually found on

- a) spindles of bench vices
- b) railway carriage coupling
- c) feed mechanism of machine tool
- d) screw cutting lathe.

CS/B. TECH (ME / PE) / SEM-5 / ME-503 / 2010-11

GROUP – B**(Short Answer Type Questions)**Answer any *three* of the following. $3 \times 5 = 15$

2. A pin in a knuckle joint as shown in Fig. 1 is subjected to an axial load of 90 kN. Assume that the thickness of the eye is to be 1.5 times the diameter of the pin. The allowable stress of the material in tension and compression due to bending is 60 MPa and the allowable stress in shear is 30 MPa. The allowable bearing stress is 20 MPa. Determine the required pin diameter.

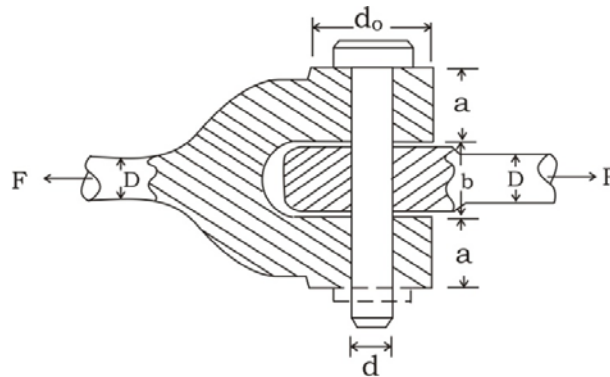


Figure 1

3. a) State Maximum Shear Stress Theory of Failure.
- b) In a bi-axial stress problem the stresses in X and Y directions are $\sigma_x = 200$ MPa and $\sigma_y = 100$ MPa. What is the maximum principal stress and maximum shear stress in MPa ? $2 + 3$

CS/B. TECH (ME / PE) / SEM-5 / ME-503 / 2010-11

4. A shaft of rectangular cross-section is welded to a support by means of fillet welds as shown in figure 2. Determine the size of the welds, if the permissible shear stress in the weld is limited to 75 N/mm^2 .

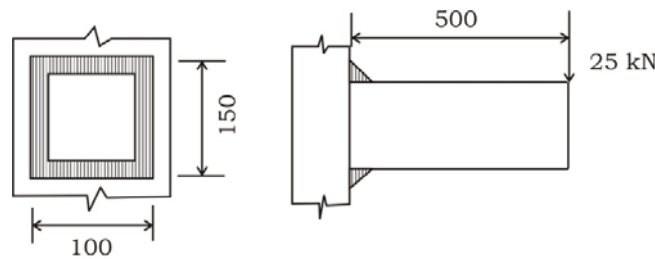


Figure 2

5. A hollow circular shaft is being designed to transmit 120 kW at 105 rpm. The inside diameter of the shaft is to be one-half of the outside diameter. Assuming that the allowable shear stress is 45 MPa, calculate the minimum required outside diameter.
6. Two mild steel tie bars, for a bridge structure are to be joined by means of a butt joint with double straps. The thickness of the tie bar is 12 mm and carries a tensile load of 400 kN. Design the joint completely taking the allowable stresses as $f_t = 100 \text{ N/mm}^2$; $f_s = 75 \text{ N/mm}^2$; and $f_c = 150 \text{ N/mm}^2$.

CS/B. TECH (ME / PE) / SEM-5 / ME-503 / 2010-11

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. Design a bushed-pin type of flexible coupling to connect a pump shaft to a motor shaft transmitting 40 kW at 1000 r.p.m. The overall torque is 25 per cent more than mean torque. The allowable shear and crushing stress for shaft and key material is 40 MPa and 80 MPa respectively. The allowable shear stress for cast iron is 15 MPa. The allowable bearing pressure for rubber bush is 0.8 N/mm^2 . The material of the shaft, key and pin is same.
8. a) What is an axle ? How does it differ from a shaft ?
- b) An overhung shaft carries a pulley of 1000 mm diameter, whose centre is 250 mm from the centre of the nearest bearing. The weight of the pulley is 600N and the angle of lap of the belt may be assumed as 180° . The pulley is driven by a motor, placed below it at an angle of 45° . If the permissible tension in a belt is

CS/B. TECH (ME / PE) / SEM-5 / ME-503 /2010-11

2500N and coefficient of friction is 0.3, determine the size of the shaft. Assume the permissible shear stress in the shaft material as 50 MPa. Take shock and fatigue factor in torsion and bending as 2 and 1.5 respectively.

3 + 12

9. a) The following data apply to the C clamp shown in figure 3. Trapezoidal thread :

5 threads per cm (single threaded)

Outside diameter = 12 mm

Coefficient of thread friction = 0.25

Mean collar radius = 6.4 mm

Load = 4500N

Force exerted by the operator at the end of lever = 90N

Determine :

- i) length of handle L

CS/B. TECH (ME / PE) / SEM-5 / ME-503 / 2010-11

- ii) maximum shear stress in the body of the screw and where this exists.
- iii) bearing pressure on the threads

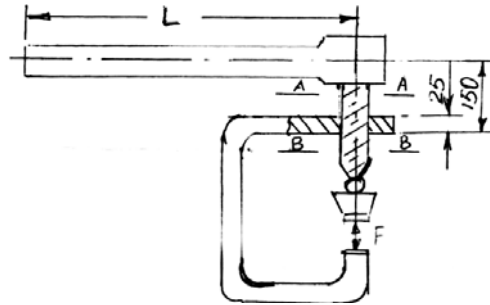


Figure 3

- b) A bearing housing shown in the Figure 4 is fastened to a frame by 6 bolts spaced equally on a 250 mm PCD of which 2 are positioned on the horizontal line. The bearing flange diameter is 300 mm and a load of 50 kN is applied at 275 mm from the frame. Determine the size of the bolt. The material of the bolt is C20 having yield strength of 245 N/mm^2 and factor of safety is 3.

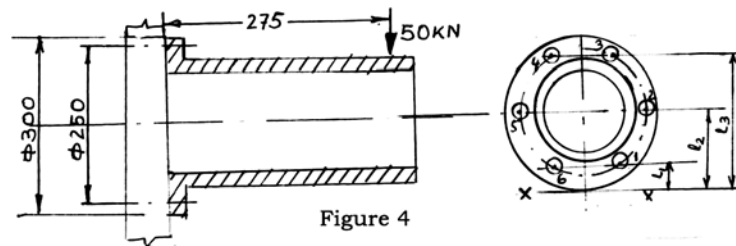


Figure 4

8 + 7

CS/B. TECH (ME / PE) / SEM-5 / ME-503 /2010-11

10. A helical compression spring, made of circular wire, is subjected to an axial load, which varies from 2.5 kN to 3.5 kN. Over this range of force, the deflection of the spring is approximately 5 mm. The spring index can be taken as 5. The spring has square and ground ends. The material of the spring is patented cold-drawn steel wire with ultimate tensile strength of 1050 N/mm^2 and modulus of rigidity of 81370 N/mm^2 . The permissible shear stress of the spring wire may be taken as 50% of the ultimate tensile strength. Design the spring and find out :
- (i) wire diameter, (ii) mean coil diameter, (iii) number of active coils, (iv) total number of coils, (v) solid length of the spring, (vi) free length of the spring, (vii) required spring rate, and (viii) actual spring rate.
11. a) A bracket is riveted to a column by six rivets of equal size as shown in Fig. 5. Shear stress in the rivet is limited to 15 MPa. Determine the diameter of the rivet.

CS/B. TECH (ME / PE) / SEM-5 / ME-503 / 2010-11

- b) Find the stress at the inner and outer surfaces at section A-A of the frame shown in Fig. 6 if the force $F = 2200\text{N}$.

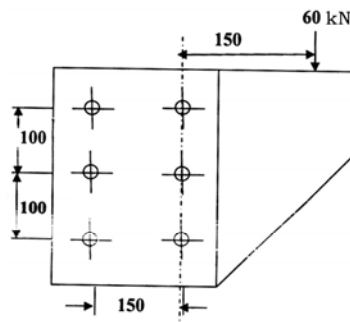


Fig. 5

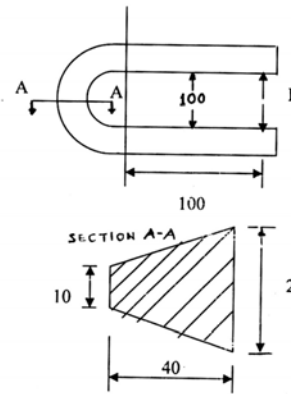


Fig. 6

[All dimensions are in mm]

8 + 7

=====