

or's Signature : ..... *Shen* .....

**CS/B.Tech(ME/PE)/SEM-5/ME-503/2009-10**

**2009**

**DESIGN OF MACHINE ELEMENTS**

Allotted : 3 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 )**

Choose the correct alternatives for the following :

$10 \times 1 = 10$

- i) In the assembly of pulley, key and shaft
  - a) Pulley is made the weakest
  - b) Key is made the weakest
  - c) Key is made the strongest
  - d) All the three are designed for equal strength.
- ii) 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.

iii) In a steam engine, the piston rod is usually connected to the cross-head by means of a

- a) Knuckle joints                      b) Universal joint  
c) Flange coupling                      d) Cotter joint.

iv) 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) requires locking nut.

v) If a shaft made of ductile material is subjected to combined bending and twisting moments, which of the failure theory would give the conservative value ?

- a) Maximum principal stress theory  
b) Maximum shear stress theory  
c) Maximum strain energy theory  
d) Maximum distortion energy theory.

vi) The property of a material, which enable it to resist fracture due to high impact load, is known as

- a) Elasticity                                  b) Endurance  
c) Strength                                      d) Resilience.

vii) Lowest value of riveted joint efficiency is assumed in case of

- a) single riveted butt joint  
b) single riveted lap joint  
c) double riveted butt joint  
d) double riveted lap joint.

viii) When a nut is tighten by placing a washer below it the bolt will be subjected to

- a) tension                                      b) compression  
c) shear    d) combined load.

ix) Maximum shear stress theory is applicable for

- a) ductile materials                      b) brittle materials  
c) elastic materials                      d) all of these.

x) Which of the following is wrong ?

The advantages of power screw is

- a) high capacity  
b) high mechanical advantage  
c) high efficiency  
d) low noise in operation.

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

2. Compare the stress distribution in thin and thick walled pressure vessels.

A hydraulic press has a maximum capacity of 1000 kN. The piston diameter is 250mm. Calculate the wall thickness if the permissible strength of cylinder material is 80 MPa. This material may be assumed as a brittle material.  $2 + 3$

3. a) Explain the methods used to make the riveted joint leak proof.

b) A single riveted lap joint is to make of 10 mm plates. Find the diameter of rivets, their pitch and the efficiency of the joint. Take permissible shear stress is 64 MPa and permissible tensile stress is 80 MPa and so design the joint that its strength to withstand shear of rivets equal its strength to withstand tearing of the plate across the line of rivet holes.  $2 + 3$

4. In belt drive, for maximum power transmission, show that one-third of the maximum tension in the belt is absorbed as centrifugal tension.  $5$

5. A steel shaft of yield strength  $750 \text{ N/mm}^2$  is to subjected to static load consisting of bending moment 10 kN-m and a torsional moment of 30 kN-m. Determine the diameter of the shaft using maximum shear stress theory. Assume a factor of safety is 2.  $5$

6. Design a helical compression spring for a maximum load of 1 kN for a deflection of 25 mm using the value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is  $84 \text{ kN/mm}^2$ .

Take Wahl's factor,  $K = (4C - 1) / (4C - 4) + 0.615 / C$ , where  $C$  = spring index.  $5$

**GROUP - C****( Long Answer Type Questions )**Answer any *three* of the following.  $3 \times 15 = 45$ 

7. a) Prove that for thin walled pressure vessel

$$f_1 / r_1 + f_2 / r_2 = p / t$$

where  $f_1$  = hoop stress,  $f_2$  = circumferential stress,  
 $r_1$  and  $r_2$  = radius of curvature of circumference and meridian respectively,  $t$  = thickness of shell wall.

- b) The hydraulic cylinder 400 mm bore operates at a maximum pressure of  $5 \text{ N/mm}^2$ . The piston rod is connected to the load and the cylinder to the frame through hinged joints. Design

i) Cylinder

ii) Piston rod

iii) Hinge pin

iv) Flat end cover.

The allowable tensile stress for the cast steel cylinder and end cover is  $80 \text{ N/mm}^2$  and for piston rod is  $60 \text{ N/mm}^2$  and shear stress for the hinge pin is  $45 \text{ N/mm}^2$ .  $4 + 11$

9. a) The force required to open or close a certain submerged sliding water gate is estimated at 27 kN. It is required to design a single threaded steel screw such that one man exerting a pull of 360 N at the periphery of a hand-wheel 1.0 m in diameter, attached directly to the screw can operate the gate. The greatest unsupported length of the screw is found to be 1.5 m. Co-efficient of friction for screw and collar is 0.15. The crushing strength of the material is  $210 \text{ MN/m}^2$ , the maximum working tensile or compressive stress is  $210 \text{ MN/m}^2$ , the maximum working tensile or compressive stress is  $70 \text{ MN/m}^2$ ,  $E = 210 \text{ GN/m}^2$ .

3 + 12

9. a) Two round tie rods of a roof truss are connected by means of a coupling joint (Turnbuckle). The maximum pull in the rod is 50 kN. Assuming that the allowable stress in tension compression and shear as  $70 \text{ N/mm}^2$  ;  $80 \text{ N/mm}^2$  and  $30 \text{ N/mm}^2$  respectively. Design and draw the joint. How much would be the rods drawn together for one turn of the coupler ?

- b) Design a cotter joint to connect a piston rod to the cross-head. The maximum steam pressure on the piston rod is 35 kN. Assuming that all the parts are made of the same material having the following permissible stress :

$$\sigma_t = 50 \text{ MPa} ; \tau = 60 \text{ MPa and } \sigma_c = 90 \text{ MPa.}$$

7 + 8

10. An eccentrically loaded bracket is welded to support as shown in Figure 1. The permissible shear stress for the weld material is  $55 \text{ N/mm}^2$  and the load is static. Determine the throat and leg dimensions for the welds. All the dimensions in the figure are in mm.

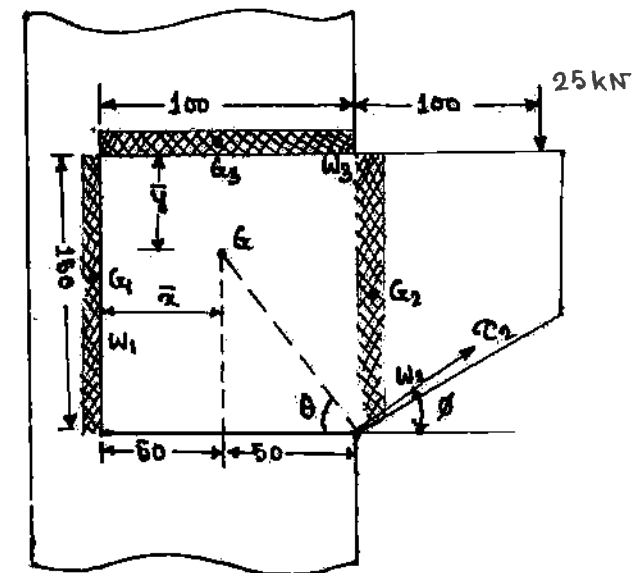


Figure 1

11. a) A 75 mm diameter solid shaft is welded to a flat plate as shown in Figure 2. If the size of the weld is 20 mm, find the maximum normal and shear stress in the weld.

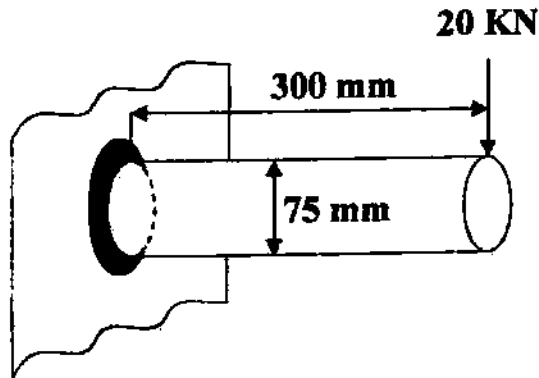


Figure 2

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- b) A helical spring is made from a wire of 6 mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 MPa and modulus of rigidity  $84 \text{ kN/mm}^2$ , find the axial load which the spring can carry and the deflection per active turn.

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