Total pages : 5 **V/SEM/MECH/2014(W)**

# MECHANICAL ENGINEERING DESIGN

[Theory-4]

*Full Marks* : 80

*Time* : 3 hours

Answer any **five** questions.

*The figures in the right-hand margin indicate marks.*

Use of Calculator and Data book are allowed

1. (*a*) What is fatigue ? 2

   (*b*) State the general procedure in machine design. 6

   (*c*) Explain the factors governing the design of machine elements. 8

2. (*a*) What do you mean by M 24 × 2 bolt ? 2

   (*b*) Find the size of the bolts required for a CI steam engine cylinder head. The diameter of the cylinder is 300 mm and the steam pressure is 0.7 MPa. No. of bolts required is 12 and assume permissible tensile stress as 28 MPa. 6

( *Turn Over* )







   (*c*) A triple riveted lap joint with zig-zag riveting is to be designed to connect two plates of 6 mm thickness. Determine the dia of rivet, pitch of rivets and distance between the rows of rivet. Indicate how the joint will fail. Assume : $\sigma_t$ = 120 MPa, $\tau$ = 100 MPa and $\sigma_c$ = 150 MPa. 8

3. (*a*) What is the effect of keyway ? 2

   (*b*) A shaft 30 mm diameter is transmitting power at a maximum shear stress of 80 MPa. If a pulley is connected to the shaft by means of a rectangular sunk key, find the dimension of the key so that the stress in the key is not to exceed 50 MPa and length of the key is 4 times the width. 6

   (*c*) Design a cast iron protective flange coupling to connect two shafts in order to transmit 7.5 kW at 720 r.p.m. The following permissible stresses may be used : 8

   Permissible shear stress for shaft, bolt and key material = 33 MPa

   Permissible crushing stress for bolt and key material = 60 MPa

   Permissible shear stress for the cast iron = 15 MPa.

4. (*a*) What is the function of a lever ? 2

(*b*) A hollow steel shaft transmits 600 kW at 500 r.p.m. The maximum shear stress is 62.4 MPa. Find the outside and inside diameter of the shaft, if the outer diameter is twice of inside diameter, assuming that the maximum torque is 20% greater than the mean torque. 6



(*c*) A foot brake lever has following data :
Length of lever from the centre of gravity of the spindle to the point of application of load = 1 meter
Maximum load on the foot plate = 800 N
Overhang from the nearest bearing = 100 mm
Permissible tensile and shear stress = 70 MPa
Find the diameter of the shaft and dimension of the ractangular arm assuming width of the arm is three times the thickness. 8

5. (*a*) Write down the expression for length of belt of cross-belt drive. 2

(*b*) With neat sketch explain the function and working of fast and loose pulley. 6

(*c*) A leather belt, 125 mm wide and 6 mm thick transmits power from a pulley 750 mm diameter which runs at 500 r.p.m. The angle of lap is 150° and $\mu = 0.3$. If the mass of 1m$^3$ of









leather is 1 kg and the stress in the belt is not to exceed 2.75 MN/m$^2$, find the maximum power that can be transmitted. 8

6. (*a*) State the condition for maximum power transmission by a belt. 2

(*b*) A cast iron pulley transmits 7.5 kW at 300 r.p.m. The diameter of the pulley is 500 mm and has four straight arms of elliptical cross-section in which the major axis is twice the minor axis.Find the dimension of the arm if the allowable bending stress is 160 N/mm$^2$. 6

(*c*) A screw jack carries a load of 22 kN. Assume the coefficient of friction between screw and nut as 0.15. Neglect the collar friction and column action. The permissible compressive and shear stresses in the screw should not exceed 42 MPa and 28 MPa respectively. The shear stress in the nut should not exceed 21 MPa. The bearing pressure on the nut is 14 N/mm$^2$. Design only screw and nut. 8

7. (*a*) Define solid length and free length of a closely coiled helical spring. 2

(*b*) Explain surge in springs. State the methods for eliminating the surge in spring. 6

(c) Design a compression helical spring to carry a load of 500 N with a deflection of 25 mm. The spring index may be taken as 8. Assume the following values for the spring material : 8

Permissible shear stress = 350 MPa

Modulus of rigidity = 84 kN/mm²

Wahl's factor $= \frac{4c-1}{4c-4} + \frac{0.615}{c}$, where

$c$ = spring index

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