Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(N)/ME/PE/SEM-5/ME-503/2012-13

2012

DESIGN OF MACHINE ELEMENTS

Time 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)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) In welded joint the throat of weld as compared to size of weld is

      a) About same size b) About 0·7 times

      c) About 0·5 times d) About 0·25 times

      e) About 1·25 times.

   ii) If the tearing efficiency of a riveted joint is 75%, then the ratio of diameter of rivet to the pitch is equal to

      a) 0·25 b) 0·50

      c) 0·60 d) 0·75.

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 in 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 lacking nut.

v) In *V*-belt drive, belt touches

a) at bottom

b) at sides only

c) both at bottom and sides

d) could touch anywhere.

vi) Turn buckle has

a) Right hand threads on both ends

b) left hand threads on both ends

c) left hand threads on one end and right hand threads on the other end

d) threads at the middle.

vii) To ensure self locking in a screw jack, it is essential that the helix angle is

a) Larger than friction angle

b) smaller than friction angle

c) Equal to friction angle

d) such as to give maximum efficiency in lifting.

viii) A bolt of M 24 × 2 means that

a) the pitch of the thread is 24 mm and depth is 2 mm

b) the cross sectional area is 24 mm^2

c) the nominal diameter is 24 mm and pitch is 2 mm

d) the effective diameter of the bolt is 24 mm and there are two threads per cm.

ix) A cotter joint is used to transmit

a) Axial tensile load only

b) Axial compressive load only

c) Combined axial and twisting loads

d) axial tensile or compressive loads.

x) Maximum shear stress theory is applicable for

a) Ductile materials

b) Brittle materials

c) Elastic materials

d) All of these.

xi) An open coil helical spring is subjected to an axial force, the wire of the spring is subjected to

a) direct shear only

b) combined shear and bending only

c) combined shear, bending and twisting only

d) combined shear, and twisting only.

xii) The Wahl stress factor K for springs of spring index C = D/d = (Mean dia of coil / wire dia) is given by

a) $(4C - 1) / (4C - 2) + 0{\cdot}615/C$

b) $(C - 4) / (4C - 4) + 0{\cdot}615/C$

c) $(4C - 4) / (4C - 1) + 0{\cdot}615/C$

d) $(4C - 1) / (4C - 4) + 0{\cdot}615/C$.

GROUP – B

(Short Answer Type Questions)

Write short notes on any *three* of the following. 3 × 5 = 15

2. What is surge in spring ?

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 kN/mm^2, find the axial load which the spring can carry and the deflection per active turn. 2 + 3

3. Briefly explain the creep phenomena of belt.

An engine running at 150 r.p.m. drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and the pulley on the line shaft is 450 mm. A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Fine the speed of dynamo shaft, when there is a slip of 2% at each drive. 2 + 3

4. What is factor of safety ? Define factor of safety for brittle and ductile materials. What do you mean by endurance limit ? Define fatigue life. 5

5. With the help of a figure, briefly explain how Goodman diagram and Soderberg diagram are used for fatigue design of a component. 5

6. Stresses induced at a critical point in a machine component made of steel 45C8 ($\sigma_{yp} = 380$ N/mm^2) are as follows $\sigma_x = 100$ N/mm^2, $\sigma_y = 40$ N/mm^2 and $\tau_{xy} = 80$ N/mm^2. Calculate the factor of safety by

   (i) Maximum normal stress theory

   (ii) Maximum shear stress theory. 5

GROUP – C

(Long Answer Type Questions)

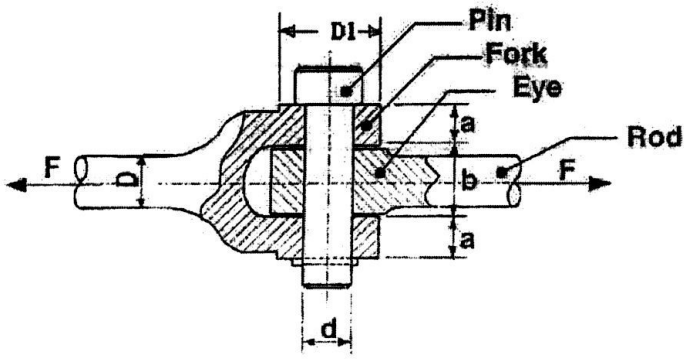
Answer any *three* of the following. 3 × 15 = 45

7. The lead screw of a lathe has Acme threads of 5 cm outside diameter and 8 mm pitch. The screw must exert an axial pressure 2500 N in order to drive tool carriage. The thrust is carried on a collar 11 cm outside diameter and 55 mm inside diameter and the lead screw rotates at 30 r.p.m. Determine

   a) the power required to drive the screw

   b) the efficiency of the lead screw. Assume a co-efficient of friction of 0·15 for the screw and 0·12 for the collar.

8. It required to design a knuckle joint as shown in Fig. 1. The axial force F acting on the rod is 15 kN. The fork, eye and the pin is made of plain carbon steel 30C8 with a tensile yield strength of 400 MPa. The compressive yield strength is same as that in tension. Shearing yield stress is 0·577 S_{yt}. Using a factor of safety of 5, find D, d, b, a and $D1$ as show in the figure.



9. A protected type rigid coupling is used to transmit 37·5 kW at 180 rpm from the output shaft of an electric motor to input shaft of a hydraulic pump. The design torque is 1·5 times the rated torque. The shafts, keys and bolts are made of plain carbon steel 30C8 (σ_{yt} = 400 N/mm^2) and the factor of safety is 2·5. The yield strength in compression can be assumed as 1·5 times the tensile yield strength. The flanges are made of Grey cast iron *FG*200 (σ_{ut} = 200 N/mm^2). Assume that the ultimate shear strength to be 50% of the ultimate tensile strength and the factor of safety as 6. The number of bolts is 4. Design the coupling and specify the dimensions of its components.

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

    (viii) actual spring rate.

11. A shaft is supported by two bearing placed by 1m apart. A 600 mm diameter pulley is m is counted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2·25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and it is driven with the help of electrical motor and belt, which placed horizontally to the right. The angle of connect for both the pulleys is angle 180° and coefficient of friction is 0·24. Determine the suitable diameter for a solid shaft allowing working stress of 63 Mpa in tension and 42 Mpa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley.