(Following Paper ID and Roll No. to be filled in your Answer Book)

**PAPER ID : 2177** Roll No. | | | | | | | | | | |

**B.Tech.**

**(SEMESTER-V) THEORY EXAMINATION, 2012-13**

# DESIGN OF MACHINE ELEMENTS

*Time : 3 Hours ]* *[ Total Marks : 100*

## Section – A

1. Answer all the questions : **10 × 2 = 20**

   (a) What are the preferred numbers ?

   (b) How a ductile material behaves at yield point ?

   (c) What is herringbone gear ? State its applications.

   (d) What are the various gear tooth failures ?

   (e) What are the functions of a key ?

   (f) What are the types of misalignments between two shafts ?

   (g) What is Wahl factor ? Why is it used ?

   (h) Why are connecting rods are made of I section ?

   (i) What are the functions of piston ?

   (j) What is nip of leaf spring ?

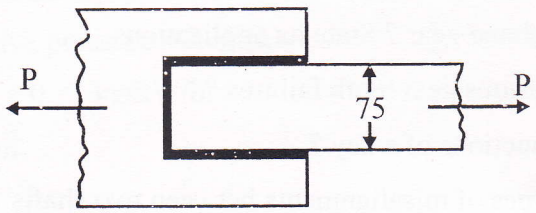
## Section – B

2. Answer any **three** parts of the following : **3 × 10 = 30**

   (a) A copper bar 50 mm in diameter is placed with a steel tube 75 mm external diameter and 50 mm internal diameter of exactly the same length. The two pieces are rigidly fixed together by two pins 18 mm in diameter, one at each end passing through the bar and tube. Calculate the stress induced in the copper bar, steel tube and pins if the temperature of the combination is raised by 50%. The modulus of elasticity is 210 GPa and 105 GPa and coefficient of thermal expansion is $11.5 \times 10^{-6}$/°C and $17 \times 10^{-6}$/°C respectively for steel and copper.

(b) A gear drive is required to transmit a maximum power of 22.5 kW. The velocity ratio is 1 : 2 and r.p.m. of the pinion is 200. The approximate centre distance between the shafts may be taken as 600 mm. The teeth has 20° stub involute profiles. The static stress for the gear materials (which is cast iron) may be taken as 60 MPa and face width as 10 times the module. Find the module, face width and number of teeth on each gear. Check the design for dynamic and wear loads. The deformation or dynamic factor in the Buckingham equation may be taken as 80 and the material combination factor for the wear as 1.4.

(c) A plate 75 mm wide and 12.5 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld as shown in Figure. The maximum tensile and shear stresses are 70 MPa and 56 MPa respectively. Find the length of each parallel fillet weld, if the joint is subjected to both static and fatigue loading. Assume a length of 12.5 mm for starting and stopping of weld run. Take stress concentration factor for transverse weld as 1.5 and for parallel fillet weld as 2.5.




(d) What are the stresses to which an over hanging shaft is subjected to ? How would you proceed to design such a crank shaft ?

(e) Design a spring for spring loaded safely valve for the following conditions :

Operating pressure 10 MPa

Diameter of valve seat 100 mm

Design shear stress for spring is 400 MPa

$G = 0 : 86 \times 10^5$ MPa

The spring is to be kept in a casing 120 mm of inside diameter and 400 mm long. The spring should be at a maximum lift of 6 mm, when the pressure is 107.5 N/cm$^2$.

## Section – C

3. Answer any **one** part of the following : **5 × 10 = 50**

(a) The principal stresses induced at a point in a machine component made of steel 50C4($S_{yt}$ = 460 N/mm$^2$) are as follows :

Maximum principal stress = 200 N/mm$^2$ and

Minimum principal stress = 1.50 N/mm$^2$. Calculate the factor of safety by

(i) Maximum shear stress theory

(ii) Distortion energy theory and

(iii) Maximum principal stress theory

(b) A stepped shaft transmits a torque varying from 800 Nm to 1200 Nm. The ratio of diameter is 1.5 and the stress concentration factor is 1.2. Determine the diameter of the shaft for an infinite life for a design factor of safety 1.8. The ultimate tensile strength of the material of the shaft is 600 MPa. Yield stress of the material is 450 MPa. Consider the size effect and surface finish effect.

4. Answer any **one** part of the following :

(a) Design a pair of helical gears for 20 kW at 1440 RPM for reduction of 3 : 1. The driver gear is having 24 teeth and helix angle 30° for 20° full depth system. Face width may be taken as 4 times circular pitch and overhang each gear is 125 mm. Gears are of cast steel with safe static stress of 48 MPa. Assume form factor and velocity factor.

(b) Enumerate the design procedure for worm gearing.

5. Answer any **one** part of the following :

(a) Design a bushed –pin type flexible coupling to connect a pump shaft to a motor shaft, transmitting 32 kW at 960 rpm. The overall torque is 20% more than mean torque. The material properties are as follows :

(i) The allowable shear and crushing stress for shaft and key material is 40 MPa.

(ii) The allowable shear stress for cast iron is 15 MPa.

(iii) The allowable bearing pressure for rubber bush is 0.8 N/mm$^2$

(iv) The material of the pin is same as that of shaft and key.

Draw neat sketch of the coupling.

(b) A triple riveted lap joint with zigzag riveting is to be designed to connect two plates of 6 mm thickness. Determine the diameter of the rivet, pitch of rivets and distance between the rows of the rivets. Indicate how the joint will fail. Also, find the efficiency of the joint. The permissible stresses are 120 MPa in tension, 100 MPa in shear and 150 MPa in crushing.

6. Answer any **one** part of the following :

(a) Following data refers to 4-stroke cycle diesel engine cylinder :

Cylinder bore = 0.15 m

Stroke = 0.1875 m

Speed = 1200 rpm

Maximum gas pressure = 5.6 MPa. Determine

(i) The dimensions of an I-section connecting rod of forged steel with elastic limit compressive stress of 350 MPa. The ratio of length of connecting rod to the length of crank is 4 and factor of safety is 5.

(ii) The writ pin and crank pin dimensions on the basis of the bearing pressure of 10.5 MPa and 6.5 MPa.

(b) Design an aluminium alloy piston for a single acting four stroke engine for the following data Cylinder bore = 400 mm.

Cylinder bore = 400 mm

Stroke = 375 mm

Maximum gas pressure = 9 MPa

Break mean effective pressure = 2 MPa

Fuel consumption = 0.22 kg/kW/hr

Speed = 50 rev/min.

7. Answer any **one** part of the following :

(a) Design a helical spring for a spring loaded safely valve (Ramsbottom safely valve) for the following conditions : Diameter of valve seat = 65 mm; operating pressure = 0.7 $N/mm^2$; Maximum pressure when the valve blows off freely = 0.75 $N/mm^2$; Maximum lift of the valve when the pressure rises from 0.7 to 0.75 $N/mm^2$ = 3.5 mm; maximum allowable stress = 550 MPa; Modulus of rigidity = 84 $kN/mm^2$; Spring index = 6. Draw a neat sketch of the free spring showing the main dimensions.

(b) Describe the design procedure of leaf spring.

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