Total No. of Questions : 10]

SEAT No. :

P2838

[Total No. of Pages : 8

[4958]-1011
T.E.(Mechanical)
DESIGN OF MACHINE ELEMENTS - I
(2012 Course) (Semester - I) (302041)

Time : 3 Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Neat diagram must be drawn wherever necessary.***
2) ***Assume suitable data, if necessary.***
3) ***Figures to the right indicate full marks.***

Q1) a) What is 'series of preferred numbers? In an industry, it is required to standardize 11 shafts from 100 mm to 1000 mm diameter. Specify the series to which they belong and calculate the diameters for the shaft. **[6]**

b) Show that the compressive stress induced in a square key due to torque transmitted is twice the shear stress. **[4]**

OR

Q2) a) What are splines? **[4]**

A standard splined connection (8 × 52 × 60 mm) is used for the gear and the shaft assembly of a gearbox. The splines transmit 20 kW power at 300 rpm. The dimensions of the splines are as below

Major diameter = 60 mm

Minor diameter = 52 mm

Number of splines = 8

Permissible normal pressure on the splines is limited to 6.5 MPa. And coefficient of friction is 0.06. Calculate

i) The length of hub of the gear.

ii) The force required for shifting the gear.

b) A component in a machine is subjected to two -dimensional stresses. the tensile stress in the X-direction varies from 40 MPa to 100 MPa, while the tensile stress in the Y-direction varies from 10 MPa to 80 MPa. The

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frequency of variation of these stresses is equal. The corrected endurance limit of the component is 270 MPa. The ultimate tensile strength of the material of the component is 660 MPa. Evaluate the factor of safety. **[6]**

Q3) a) A right angled bell-crank lever is to be designed to raise a load of 5000 N at the short arm end. The lengths of short and long arms are 100 mm and 450 mm respectively. The material of construction for the lever and the pins is steel 30 C 8 (σ_{yt} = 400 MPa) and the factor of safety is 5. The permissible bearing pressure on the pin is 10 MPa. The lever has a rectangular cross-section and the ratio of width to the thickness is 3 : 1 the length to diameter ratio of the falcrum pin is 1.25 : 1. Calculate **[6]**

i) The Diameter and the length of fulcrum pin

ii) The shear stress in the pin

iii) The dimensions of the cross-section of the lever.

It is given that the arm of the bending moment on the lever extends up to the axis of the fulcrum.

b) State the theory of elastic failure on which ASME code is based. Discuss an importance of shock and fatigue factors in evaluating τ_{max} and σ.**[4]**

OR

Q4) a) Discuss the design of hollow shaft on torsional rigidity basis. Using this basis evaluate the inside and outside diameters of the shaft for following data **[4]**

i)	Power transmitted by shaft	:	45 kW
ii)	Speed of shaft	:	500 rpm
iii)	Ratio of inside diameter to outside diameter	:	0.6
iv)	Material of shaft	:	Plain carbon steel with (τ_{all} = 84 mpa).

where τ_{all} - permissible shear stress.

b) State Miner's Equation; state it's applicability. The work cycle of a mechanical component subjected to a completely reversed bending stresses consists of the following three elements

i) $\pm$ 350 MPa for 85% of life

ii) $\pm$ 400 MPa for 12% of life

iii) $\pm$ 500 MPa for 3% of life

The material for the component is 50 C4 (σ_{ut} = 660 MPa) and the corrected endurance limit of the component is 280 MPa. Estimate the life of the component. **[6]**

Q5) a) Explain the advantages of trapezoidal threads over square threads. State the meaning of each term involved in the designation. **[5]**

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b) Derive an equation for the efficiency of the square threaded screw. Using this equation, show that the efficiency of a self locking square threaded power screw is less than 50%. **[5]**

c) The lead screw of a lathe has single-start ISO metric trapezoidal threads of 52 mm nominal diameter and 8 mm pitch. The screw is required to exert an axial force of 2kN in order to drive the tool carriage during turning operation. The thrust is carried on a collar of 100 mm outer diameter and 60 mm inner diameter. The values of coefficient of friction at the screw threads and the collar are 0.15 and 0.12 respectively. The lead screw rotates at 30 rpm. Evaluate **[8]**

i) the power required to drive the lead screw.

ii) the efficiency of the screw.

OR

Q6) a) Explain the following terms in brief **[8]**

i) Collar friction torque

ii) Self - locking screw

iii) Overhauling screw

iv) Ball screw

b) A C-clamp as shown in Fig. below, is used on the shop floor has single-start square threads of 22 mm nominal diameter and 5 mm pitch. The coefficient of friction at the threads and the collar is 0.15. The mean radius of the friction collar is 15 mm. The capacity of the clamp is 750 N. The handle is made of steel 30 C 8 (σ_{yt} = 400 MPa) It can be assumed that the operator exerts a force of 20 N on the handle. **[10]**

i) Evaluate the torque required to tighten the clamp to its full capacity.

ii) Determine the length and the diameter of the handle such that it will bend with a permanent set, when the rated capacity of the clamp is exceeded.

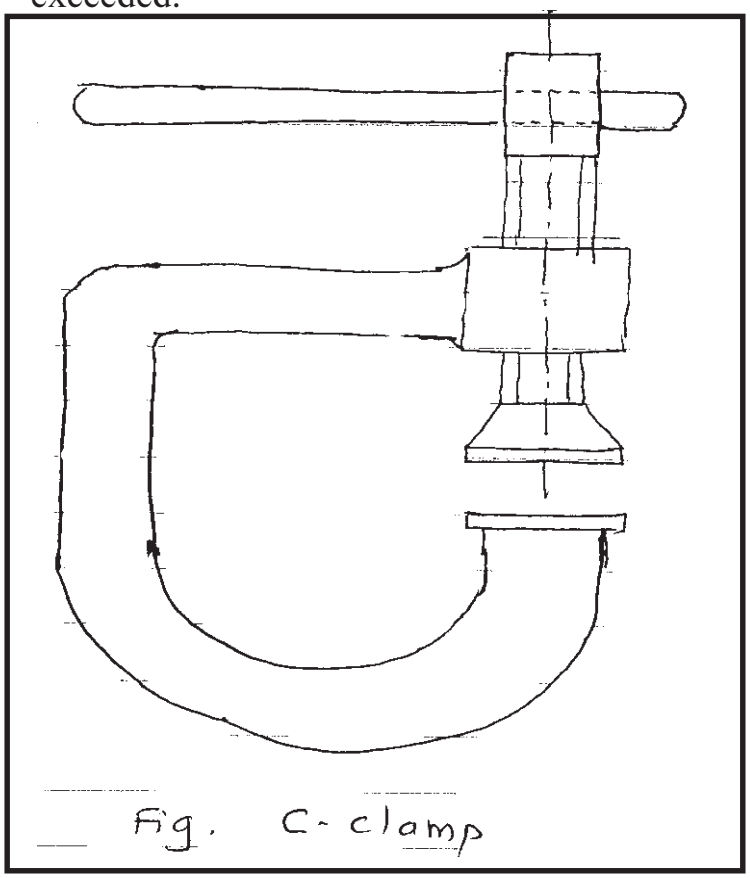


Fig. C-clamp

Q7) a) Enlist the materials used for the following **[3]**

i) Lightly loaded small bolts, studs & nuts

ii) High strength bolts

iii) Threaded fasteners where corrosion resistance is required.

b) Discuss in brief strength of butt welds and strength of parallel fillet welds. **[5]**

c) The bracket is fixed to wall as shown in fig. below, Following data is given for this bracket

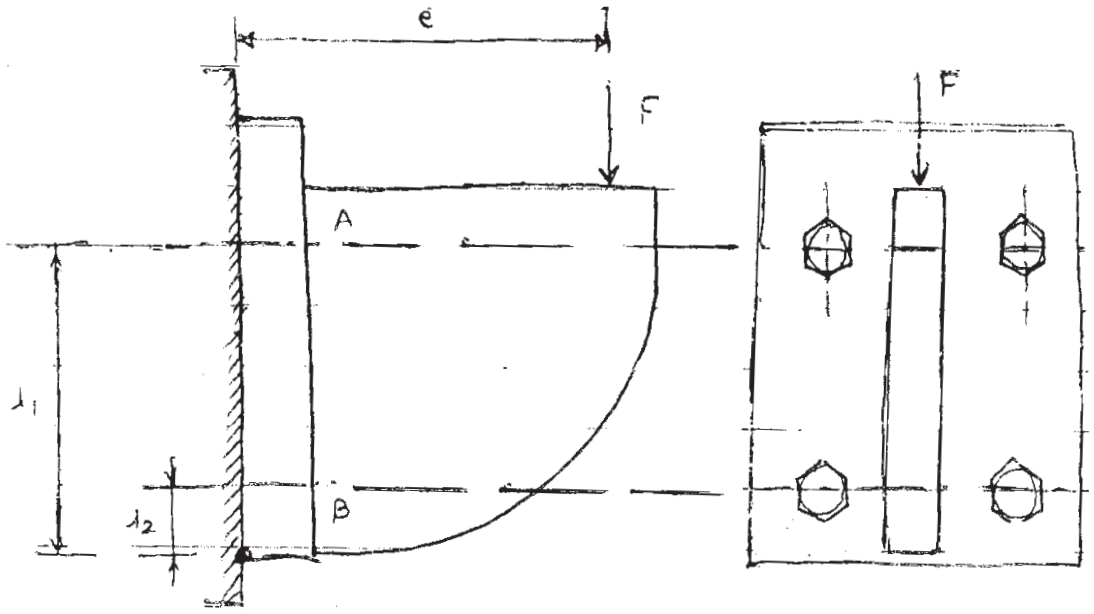
F = 25,000 N

e = 100 mm

l_1 = 150 mm

l_2 = 25 mm

There is no pre-load in the bolts. The bolts are made of 45 C8 (σ_{yt} = 380 MPa) and factor of safety is 2.5. Use maximum shear stress theory to find area of cross-section of the bolt. **[8]**



**[2 bolts at location 'A' &
2 bolts at location 'B']**

OR

Q8) a) Discuss the term 'Bolt of uniform strength'. State the use of coarse threads and fine threads. **[4]**

b) Explain the procedure in the design of bolts for eccentrically loaded bolted joints in shear. **[4]**

c) A bracket is welded to the vertical plate by two fillet welds as shown in the fig. below. Determine the weld size, if permissible shear stress is limited to 70 MPa. **[8]**

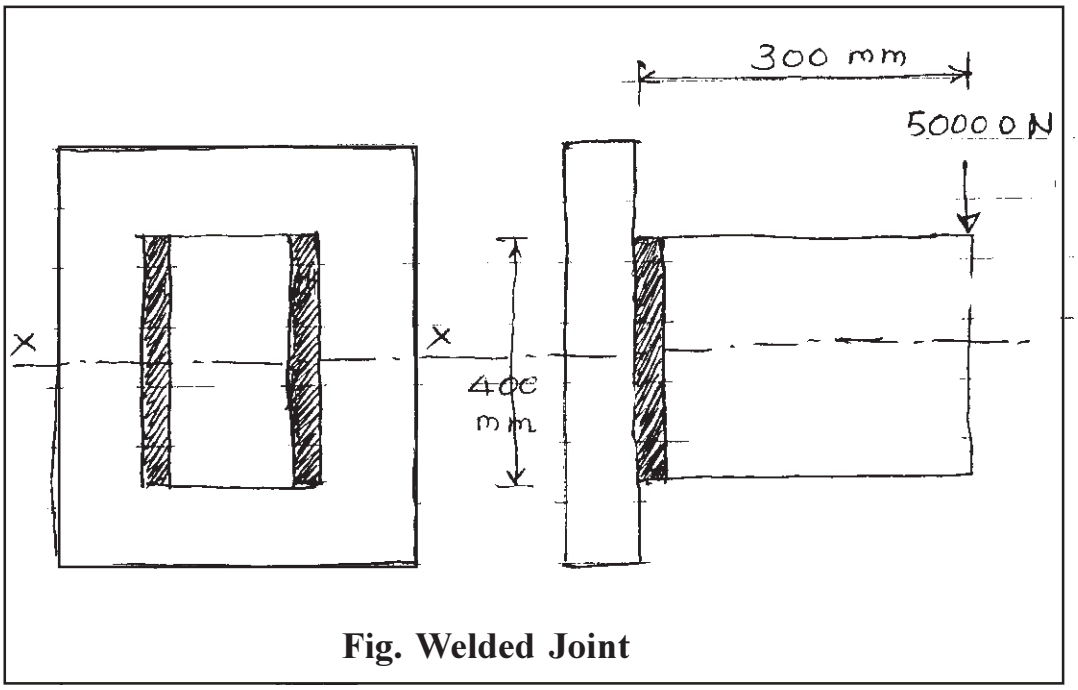


Fig. Welded Joint

Q9) a) Derive an equation for the resultant t stress in the helical spring (of circular wire). State an importance of this equation in the design of helical spring. **[6]**

b) Enlist the materials used in constructing springs. **[2]**

c) It is required to design a helical compression spring of circular wire, subjected to an axial load, which varies from 2.5kN to 3.5kN. For this range of load, the deflection of the spring should be limited to 5mm. The spring index is 5 the spring has square and ground ends. For spring wire material, σ_{ut} = 1050 MPa and G = 81370 MPa. The permissible shear stress for the spring wire should be taken as 50% of the σ_{ut}. Calculate **[8]**

i) Wire diameter and mean coil diameter.

ii) Number of active coils & total number of coils.

iii) Solid length of spring.

iv) Free length of spring.

v) Required spring rate &

vi) actual spring rate.

OR

Q10)a) Explain the following terms (Any 2) **[8]**

i) Surge in spring.

ii) Nipping of leaf springs.

iii) Style of ends of helical compressions springs

iv) Nested spring.

b) A safety valve operated by a helical tension spring through the lever mechanism is as shown in the figure below. The diameter of the valve is 50 mm. In normal operating conditions, The valve is closed and the pressure inside the chamber is 0.5 MPa. The valve is opened when the pressure inside the chamber increases to 0.6 MPa. The maximum lift of the valve is 5 mm. The spring index is 8. The spring wire material has ultimate tensile strength of 1200 MPa and modulus of rigidity of 81370 MPa. The permissible shear stress for the spring wire can be taken as 30% of the ultimate tensile strength. **[8]**

Calculate:

i) Wire diameter.

ii) mean coil diameter and

iii) number of active coils.

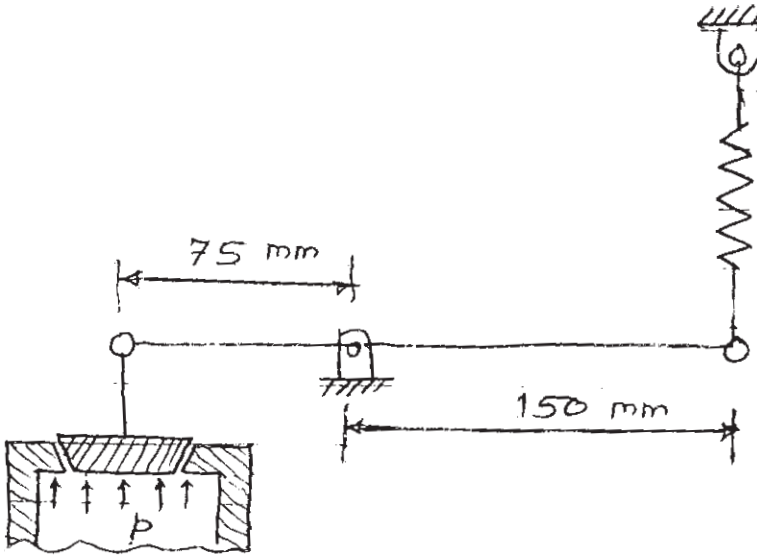


Fig. Schematic of safety valve system