T.E. (Mechanical) (Semester – I) Examination, 2010
(2008 Course)
MACHINE DESIGN – I (New)

Time : 4 Hours Max. Marks : 100

Instructions *:1) Answer* ***any three*** *questions from* ***each*** *Section.*
2) Answers to the ***two*** *Sections should be written in* ***separate*** *books.*
3) ***Neat*** *diagrams must be drawn* ***wherever*** *necessary.*
4) Black figures to the ***right*** *indicate* ***full*** *marks.*
5) ***Use*** *of electronic pocket calculator is* ***allowed.***
6) Assume suitable data, if ***necessary.***

SECTION – I

Unit – I

1. The layout of a shaft is as shown in fig. 1. Pulley D (diameter 480 mm) drives the shaft, while pulley C (diameter 150 mm) transmits power to a compressor. The belt tensions for pulley C are 1500 N and 600 N. The ratio of belt tensions for pulley D is 3.5. Find the shaft diameter as per A.S.M.E. code. Yield strength and ultimate tensile strength for shaft material are 380 MPa and 720 MPa respectively. Assume $K_b = 1.75$ and $K_t = 1.25$.

   If the solid shaft is replaced by a hollow shaft with outside diameter 30 mm, find inside diameter of the shaft. Compare the weights of the solid and hollow shaft. **16**

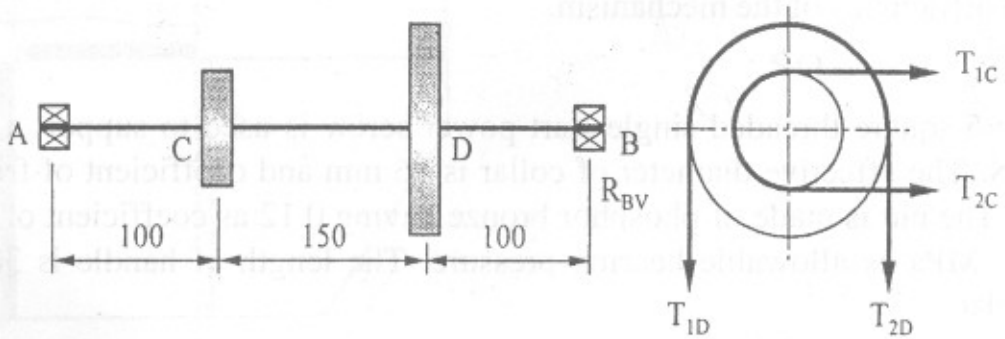


Figure 1 [Q.1.]

OR

2. a) An automobile gearbox uses a splined shaft to transmit power of 10 kW at 1500 rpm. The spline used is designated as 6×28×34. The bearing pressure is limited to 5 MPa. Calculate the length of splines in hub, based on bearing pressure criterion. Also determine force required to shift the gear, if coefficient of friction is 0.05. **4**

   b) Design a C.I. flange coupling for a mild steel shaft transmitting 90 kW at 250 rpm. The allowable shear stress for shaft material is 40 MPa. The allowable shear stress and crushing stress for key and bolt material are 45 MPa and 85 MPa respectively. The permissible shear stress for C.I. is 14 MPa. The key is having square cross-section with (width)=(thickness)=[(diameter of shaft)|4].

   The number of bolts are 6. The bolts are fitted in reamed and ground holes and are fingure tight. **12**

Unit – II

3. a) Derive formula for torque required to raise the load and torque required to lower the load by a square threaded power screw. **6**

   b) In a machine tool application, the tool holder is pulled by means of an operating nut mounted on a screw. The tool holder travels at a speed of 5 m/min. The screw has single start square threads of 48 mm nominal diameter and 8 mm pitch. The operating nut exerts a force of 500 N to drive the tool holder. The mean radius of friction collar is 40 mm. The coefficient of friction for thread and collar surfaces is 0.15. Calculate

      i) Power required to drive the screw.

      ii) Efficiency of the mechanism. **10**

OR

4. A 26×5 square threaded single start power screw is used to support a load of 12 kN. The effective diameter of collar is 46 mm and coefficient of friction is 0.15. The nut is made of phosphor bronze having 0.12 as coefficient of friction and 6 MPa as allowable bearing pressure. The length of handle is 300 mm. Calculate,

   i) Force required to raise the load.

   ii) Force required to lower the load.

   iii) Yield strength of material for factor of safety of 4.

   iv) Overall efficiency.

   v) Number of threads in nut. **16**

Unit – III

5. a) Write a note on 'Bolts of uniform strength'. **4**

   b) An eccentrically loaded bolted joint as shown in (fig. 2), is to be designed. All bolts are to be of same size. Determine the size of bolts, if permissible shear stress for bolt is 50 MPa. **14**

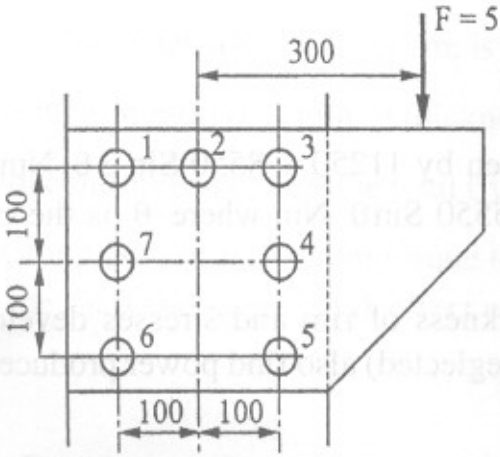


Figure 2 [Q.5. b.]

OR

6. A bracket supporting an eccentric load is welded by three fillet welds as shown in fig. 3. Determine size of weld, if permissible shear stress is limited to 66 MPa.

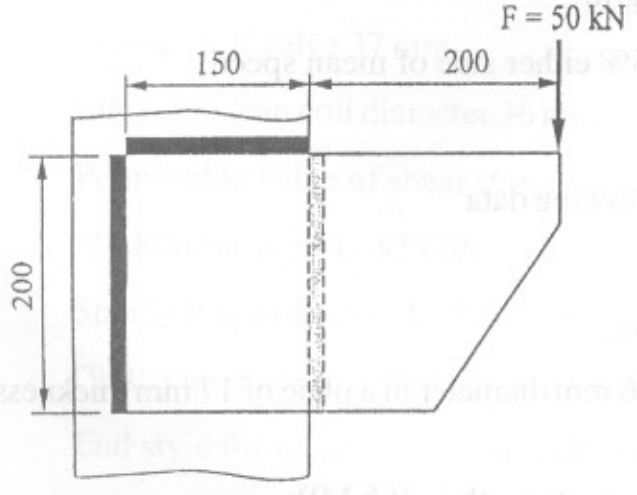


Figure 3 [Q 6]

What additional load would the bracket support if same size welding is done on all four sides ? **18**

SECTION – II

Unit – IV

7. a) Discuss the role of a flywheel. **3**

   b) Discuss the following terms **4**

      i) Coefficient of fluctuation of speed

      ii) Coefficient of fluctuation of energy.

   c) Torque developed by an engine is given by $11250 + 8550 \sin 3\theta$ Nm and load torque is expressed as $11250 + 5550 \sin\theta$ Nm where θ is the crank angle.

      For a rimmed flywheel calculate thickness of rim and stresses developed inside the rim (when effect of arms is neglected) also find power produced by the engine use following data

      Engine speed 720 rpm

      Limiting peripheral speed of the flywheel is 28.2 m/s

      Spokes and hub contribute 8% of total flywheel effect

      Rim width to thickness ratio is 1.8

      Density of Rim material is 7280 kg/m^3

      Speed fluctuation is limited to 2.5% either side of mean speed. **11**

OR

8. Design a Rimmed Flywheel using following data

   Flywheel has 6 Elliptical arms

   Flywheel is used for a punching press

   Punching press executes 20 holes of 26 mm diameter in a plate of 17 mm thickness per minute

   For the plate material, permissible shear strength is 365 MPa

   Actual punching lasts for 1/4 angular rotation of crank shaft

   Flywheel shaft is joined with crankshaft of press using a reduction gear of ratio 8 : 1

Mechanical efficiency of punching machine is 81%

During punching flywheel speed drops by 9% of mean speed

Flywheel rim radius is 0.45 m

Density of rim material is 7649.33 kg/m^3

Permissible tensile stress for rim is 8.5 MPa

For the rim ratio of width to thickness is 3.8

Rim contributes 83% of the total flywheel effect

Assume ratio of maximum torque to average torque as 2. Assume arm effect up to the shaft and neglect hub effect while designing arms. **18**

Unit – V

9. a) Draw a neat sketch of a multi-leaf spring and show its essential parts. **4**

   b) Design a helical compression spring for a pressure relief valve using following data

   Operating pressure 14.5 bar

   Valve lift 7 mm at 18% pressure rise

   Diameter of valve 37 mm

   Limiting mean coil diameter 36 mm

   Permissible value of shear stress for spring material 465 MPa

   Modulus of rigidity 83 GPa

   Standard spring wire diameters are ..., 6, 6.5, 7, 7.5, 8, 8.5,...

   Clash clearance is 15% of maximum deflection of spring

   End style for the spring is squared and ground

   Find pitch of the spring p using equation for free length L_F as $L_F = pn + 2d$.

   Where n is number of active turns and d is spring wire diameter. **12**

OR

10. a) A composite spring is subjected to a load of 12.67 kN. Inner spring is 13 mm shorter than the outer spring. Find stress developed inside both the springs using following data. **10**

	Outer spring	Inner Spring
Outside diameter of coil of spring (mm)	180	90
Number of active turns	8	14
Wire diameter (mm)	20	10
Modulus of Rigidity (MPa)	81550	80335

b) For a helical torsion spring find stresses and angular deflection using following data

Diameter of coil	105 mm
Diameter of wire	15 mm
Modulus of elasticity	2.1×10^5 N/mm^2
Number of active turns	6
Load	40.36 kN-mm.

6

Unit – VI

11. a) Derive a relation for optimum velocity of a belt for maximum power in terms of initial tension and mass per unit length of the belt. **5**

b) A V-belt is used to connect an electric motor having capacity 20 kW and running at 1440 rpm to an agitator. The pitch diameters of motor pulley and agitator pulley are 300 mm and 900 mm respectively.

The coefficient of friction for both the pulleys is 0.2

The central distance between the pulleys is 1 m.

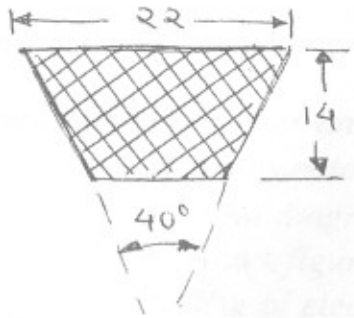
The mass density of the belt material is 0.97 gm/cc

Maximum allowable tension in the belt is 850 N

Find how many belts are required for this application.

Assume dimensions of the cross-section of belt as shown in following figure. 4

11



All the dimensions are in mm

Fig. 4 [Q. 11 (b)]

OR

12. a) Discuss stresses developed in wire ropes. 4

b) A Flat belt is used to transmit 15 kW power from a pulley running at 1440 rpm to another pulley running at 480 rpm. The central distance between the pulleys is twice the diameter of larger pulley.

The belt velocity is approximately 20.35 m/s.

The maximum allowable stress in the belt is 2.25 MPa

The density of belt material is 0.95 gm/cc

Coefficient of friction is 0.35

The thickness of belt is 5 mm

Calculate :

i) Diameter of both the pulleys

ii) Length and width of the belt

iii) Belt tensions 12