[4063] – 211

T.E. (Mechanical) (Semester – I) Examination, 2011
MACHINE DESIGN – I (New)
(2008 Pattern)

Time : 4 Hours | Max. Marks : 100

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

SECTION – I
UNIT – I

1. A steel shaft made of 40C8 is used to drive a machine. The pulleys X, Y and bearings A, B are located as shown in Fig. 1 Belt tensions are also shown. Determine diameter of the shaft using ASME code. Take S_{yt} of the shaft material as 330 N/mm^2 and S_{ut} = 600 N/mm^2. Assume K_b = 1.5 and K_t = 1.2.
If the rectangular key is made of the same material, design the key. **16**

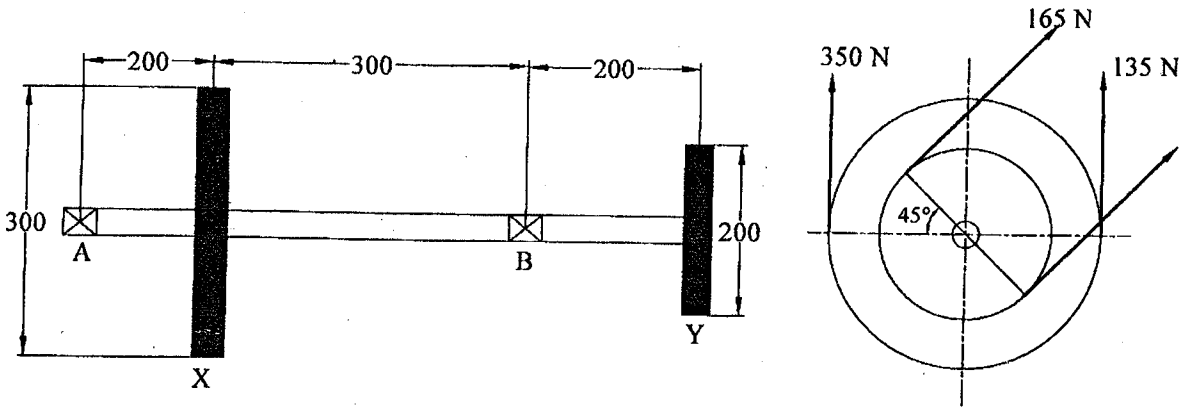

Fig. 1

OR

2. a) Compare the weights of equal length of hollow shaft and solid shaft to transmit a given torque for the same maximum shear stress. The material for both shafts is same and inside diameter is 2/3 of outside diameter for hollow shaft. **6**

   b) A protected type rigid flange coupling is used to transmit 25 kW power at 500 RPM from an engine to a machine. Design a coupling for an overload capacity of 25%. Assume following permissible stresses for the component of a coupling. Assume number of bolts as 6. **10**

	C.I. (Flange)	M.S. (Shaft & Key)	Plain Carbon Steel (Bolt)
Allowable tensile stress, N/mm²	20	60	60
Allowable shear stress, N/mm²	12	35	28
Allowable compressive stress, N/mm²	60	60	60

UNIT – II

3. a) Derive the expression for maximum efficiency of square threads. **8**

   b) A shaft straightener is as shown in fig. 2. The axial load on the screw member is 35 kN. Find the forces required at the rim of the hand wheel of 300 mm. diameter. Assume coefficient of friction in the threads as 0.12. Determine the maximum compressive stress, bearing pressure and shear stresses in the screw. Determine the efficiency of the arrangement, neglecting collar friction. Ignore the effect of bending due to force at the hand wheel. **8**

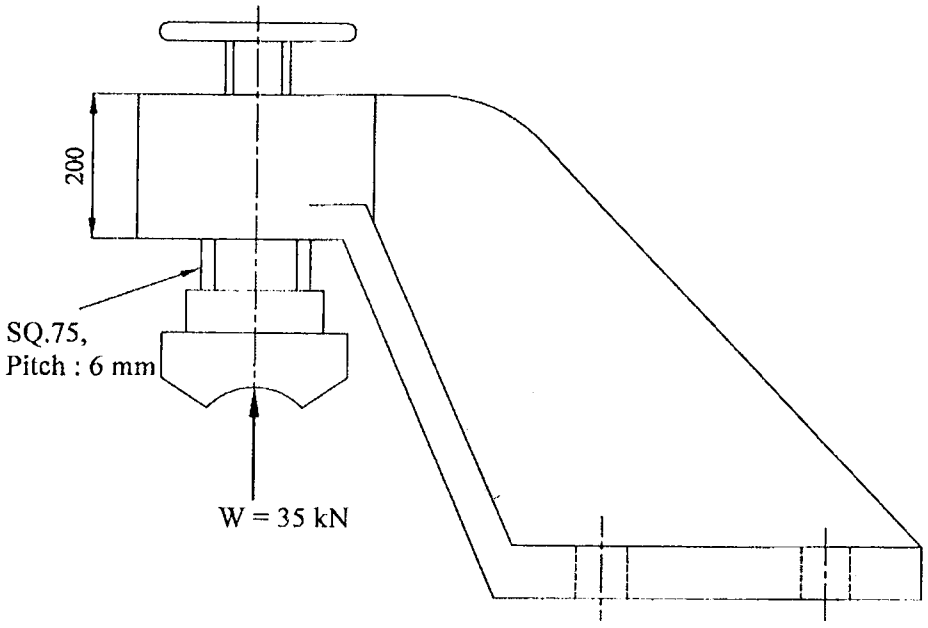

Fig. 2

OR

4. a) What are different types of screw threads used for power screws ? Give advantages and limitations of each type. **8**

   b) A power screw of a screw press is required to transmit a maximum load of 100 kN at 60 RPM. The coefficient of friction for screw threads is 0.12. The torque required for collar friction and journal bearing is about 10% of the torque required to drive the load considering the screw friction. The maximum permissible compressive stress for screw is 100 MPa, while the screw has single start square threads. Determine : **8**

   i) The screw dimensions.

   ii) The screw efficiency; and

   iii) The motor power required to drive the screw.

UNIT – III

5. a) Derive the condition for avoiding joint separation in case of bolted joints. **4**

   b) An off-set column is fixed to steel column as shown in Fig. 3 by means of four bolts. The bracket is subjected to an inclined pull of 10 kN. Determine the diameter of bolts by assuming allowable tensile stress in bolt to be 150 N/mm^2. **14**

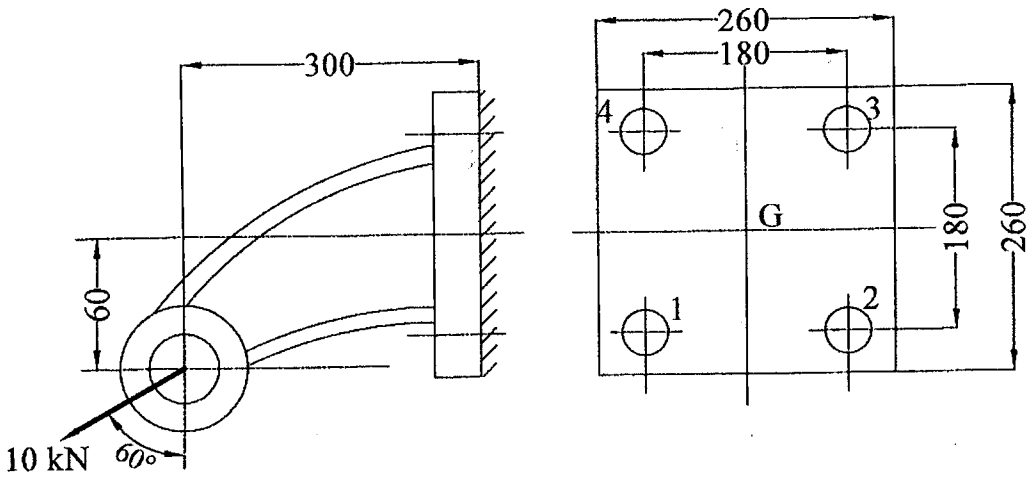

Fig. 3

OR

6. a) Give welding symbol system standardized by the American Welding Society (AWS). **6**

b) A welded connection as shown in Fig. 4, is subjected to a torsional moment of 12 kN-m about the centre of gravity of welds. If the permissible shear stress in weld deposit is 35 N/mm^2, calculate the throat and leg dimensions of weld. **12**

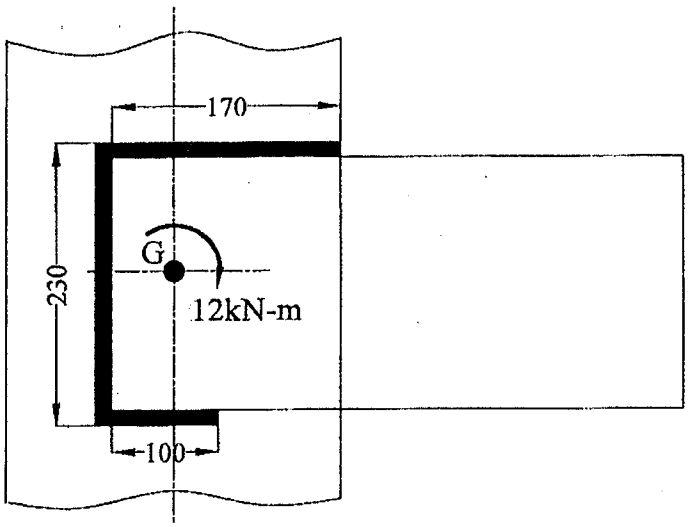

Fig. 4

SECTION – II

UNIT – IV

7. a) Discuss the following in case of Flywheel :

i) Coefficient of fluctuation of speed.

ii) Coefficient of fluctuation of energy. **6**

b) The T- θ diagram for a four stroke gas engine can be assumed to be consists of four triangles. The areas measured are : 600, 50, 30 and 150 mm^2 for power, exhaust, suction and compression strokes respectively. The scale for

the T - θ diagram is 1 mm^2= 10 Joules. The engine is running at a mean speed of 500 RPM. The load torque is constant throughout the cycle. A rimmed flywheel made of gray cast iron FG 150 (ρ = 7000 kg/m^3) is used to limit the fluctuation of speed to 3 % of the mean speed. The mean diameter of the flywheel rim is limited to 1 m. The rim contributes 90% of the required mass moment of inertia. The rim has a rectangular cross section with width to thickness ratio of 2. The number of arms are 6 having elliptical cross section with major axis twice the minor axis. If the factor of safety is 5, design the flywheel and find the power developed by engine. **12**

The allowable shear stress for the flywheel shaft is taken as 40 N/mm^2.

OR

8. a) Compare solid disk flywheel with rimmed flywheel. **4**

   b) A machine is driven by a constant torque electric motor running at a mean speed of 720 RPM. The load torque of the machine is given by $1000 + 400 \sin\theta$, where θ is the angle of rotation of the shaft. A rimmed flywheel made of gray cast iron FG200 (ρ = 7050 kg/m^3) is used to limit the coefficient of fluctuation of speed to 0.02. The rim contributes 90% of the flywheel effect. The rim has a rectangular cross section with width to thickness ratio of 1.5. The numbers of arms are 6 having elliptical cross section with major axis twice the minor axis. The factor of safety is 8. Design the flywheel and draw its dimensional sketch. Also find the required power rating of an electric motor.

   The allowable shear stress for the flywheel shaft is taken as 115 N/mm^2. **14**

UNIT – V

9 a) Explain nipping of Leaf springs. **4**

b) A concentric spring comprising two closed coil helical spring of equal free length and made of same material are compressed by 15 mm under the action of 2.5 kN force. Calculate loads on individual springs f spring index for both the springs is 5.

Calculate the main dimensions, if permissible shear stress in spring material is 240 N/mm^2 and G = 80000 N/mm^2. **12**

OR

10. a) What is surging of springs ? What remedial measures you will suggest to avoid the surging ? **6**

b) It is required to design a helical compression spring with plain ends, for carrying a maximum pure static force of 1000 N. The allowable shear stress and modulus of rigidity for spring material are 400 N/mm^2 and 85 N/mm^2 respectively. The spring rate is 48 N/mm. If spring index is 5, determine :

i) Wire diameter;

ii) Total number of coils;

iii) Free length; and

iv) Pitch. **10**

Draw neat sketch of spring and give necessary dimension.

UNIT – VI

11. a) How wire ropes are designated ? Discuss their construction and applications. **8**

b) A fan running at 4720 RPM is driven by an electric motor running at 1440 RPM through the 8 mm×250 mm flat leather belt. The centre distance is 1370 mm. The coefficient of friction between the belt and pulley is 0.35 and the belt mass is 957 kg per cubic meter. If the allowable tensile stress for the belt material is 2 N/mm^2, determine :

i) The tensions in the belt;

ii) The maximum power transmitting capacity of the belt;

iii) The diameter of the pulleys; and

iv) The required initial tension in the belt. **8**

OR

12. a) Explain the procedure for the selection of wire ropes from manufacturer's catalogue. **6**

b) Four V-belts are to be used to transmit a power from an electric motor running at 2880 RPM to a machine running at 720 RPM. The centre distance between the input and output shafts is 750 mm. The sheave groove angle is 38° and the coefficient of friction between the belt and sheave is 0.5. The density of the belt material is 1000 kg/m^3 and the allowable tensile stress for the belt material is 1.75 N/mm^2. If the cross sectional area of each belt is 612 mm^2, determine :

i) The maximum power the belt can transmit;

ii) The pulley pitch diameter ; and

iii) The initial tension required in each belt. **10**

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