53 (ME 201) ENMC

2015

ENGG. MECHANICS

Paper : ME 201

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer ***all*** *the questions.*

1. Answer ***any five*** of the following : 2×5=10

   (a) What are the coplanar-concurrent forces? State the principle of transmissibility of forces.

   (b) Define moment of force. State Varignon's principle of moment.

   (c) Write the necessary and sufficient conditions of equilibrium of a body. What is the limitation of Lami's theorem?

(d) What do you understand by 'dynamic friction' and limiting force of friction?

(e) State the laws of static friction.

(f) What is the parallel axis theorem related to moment of area?

(g) Distinguish between a truss and a frame. What do you mean by statically determinate truss?

2. Distinguish the following in brief : ***(any three)*** 2×3=6

(a) Composition and resolution of forces.

(b) Angle of friction and angle of repose.

(c) Centroid and centre of gravity.

(d) Hinged support and roller support with sketches.

3. Answer ***any two*** of the following : 2×4½=9

(a) Prove that the centroid of the area of a circular sector is

$$\bar{x} = \frac{2}{3}\frac{r \sin\alpha}{\alpha}$$, where

r = radius of the circular sector

(2α) = subtended angle of circular sector.

(b) Show that the moment of inertia of a triangle with respect to its base is

$$I_X = \frac{bh^3}{12}$$

where, b = length of the base, h = altitude of the triangle.

(c) Find the force required to drag a body of weight 'W', placed on the rough inclined plane having inclination (α) to the horizontal. The force is applied to the body along the inclined plane and the body is on the point of motion down the plane.

4. Answer ***any five*** of the following : 5×5=25

(a) A system of four forces acting at a point on a body is shown in *figure*–4(a). Determine the magnitude of resultant and direction of resultant.

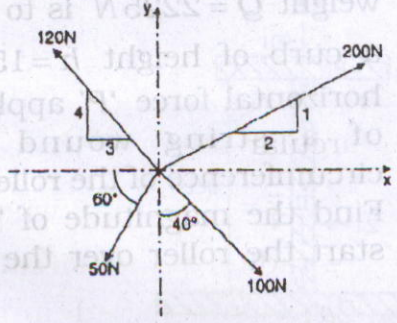


Figure – 4(a)

(b) A circular roller of weight $Q = 445N$ and radius $r = 125mm$ hangs by a tie rod $AC = 304mm$ and rests against a smooth vertical wall at B as shown in *Figure*–4(*b*). Determine the tension 'S' in the tie rod and the force R_B against the wall at B.

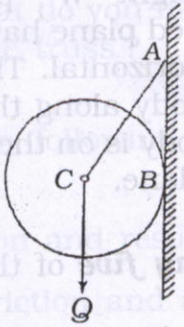


Figure – 4(*b*)

(c) A roller of radius $r = 304 \cdot 8mm$ and weight $Q = 2225N$ is to be pulled over a curb of height $h = 152 \cdot 4mm$ by a horizontal force 'P' applied to the end of a string wound around the circumference of the roller. (*Figure*–4(c). Find the magnitude of 'P' required to start the roller over the curb.

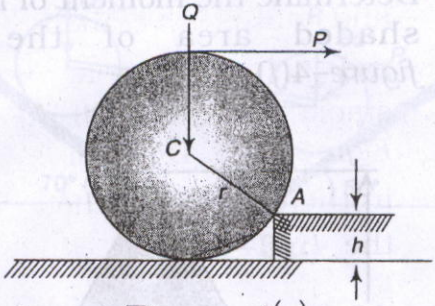


Figure – 4(c)

(d) A body resting on a horizontal plane required to a pull of 80*N* inclined at 30° to the horizontal just to move it. It was found that a push of 100*N* inclined at 30° to the horizontal just move the body. Find the weight of the body and the coefficient of friction.

(e) Determine the centroid of the unequal I-section as shown in *Figure*–4(*e*)

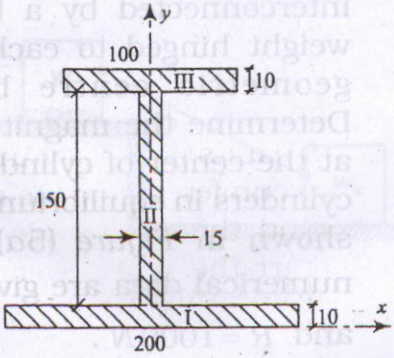
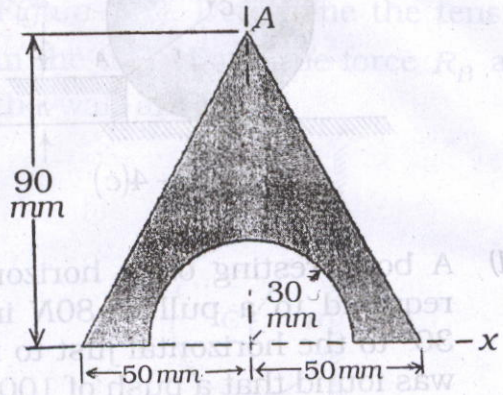


Figure – 4(e)

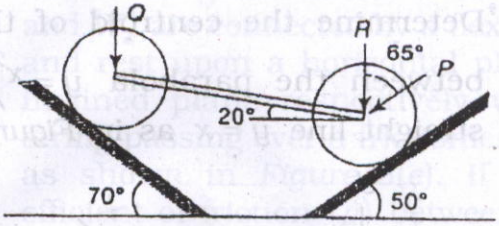
(f) Determine the moment of inertia of the shaded area of the following *figure*–4(*f*)



Figure–4(*f*)

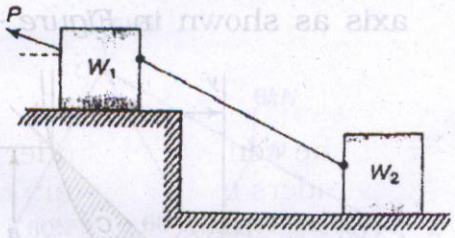
5. Solve ***any five*** of the following : 5×10=50

(a) Two cylinders weights Q and R are interconnected by a bar of negligible weight hinged to each cylinder at its geometric centre by ideal pins. Determine the magnitude of P applied at the center of cylinder R to keep the cylinders in equilibrium in the positions shown in *Figure* (5*a*). The following numerical data are given : $Q = 2000\,N$ and $R = 1000\,N$.



Figure–5(a)

(b) Two blocks having weights W_1 and W_2 are connected by string and rest on a horizontal planes as shown in *Figure–5(b)*. If the angle of friction for each block is ϕ, find the magnitude and direction of the least force P applied to the upper block that will induce sliding.



Figure–5(b)

(c) Determine the centroid of the area between the parabola $y = x^2/a$ and straight line $y = x$ as in *Figure*–5(c)

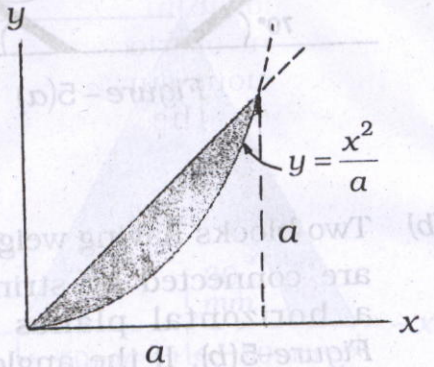


Figure – 5(c)

(d) Determine the moment of inertia of the area between the parabola $y = x^2/a$ and straight line $y = x$ about x-axis and y-axis as shown in *Figure* –5(d).

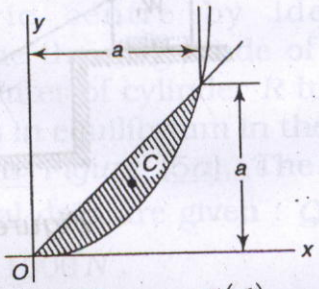
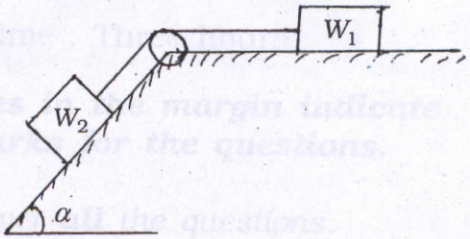


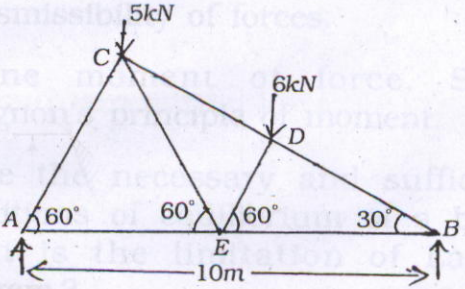
Figure – 5(d)

(e) Two rectangular blocks of weights W_1 and W_2 are connected by a flexible cord and rest upon a horizontal plane and inclined plane respectively with the string passing over a frictionless pulley as shown in *Figure*–5(*e*). If the co-efficient of friction (μ) between all the contiguous surface is same, find angle (α) for the inclined plane with horizontal at which the motion will impend. (Take $W_1 = W_2$)



Figure–5(*e*)

(f) A truss of span 10*m* is loaded as shown in *Figure*–5(*f*). Find the reactions and forces in the members of the truss.



Figure–5(*f*)