2014

ENGINEERING MECHANICS

Paper : ME 201

Full Marks : 100

Time : Three hours

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

Answer **Question No. 1** and **any four** from the rest.

1. *(a)* Fill in the blanks : $1 \times 4 = 4$

   (i) The forces, whose lines of action pass
   through a common point and do not lie
   on the same plane are known as
   _____ forces.

   (ii) _____ is the maximum value of
   static friction.

   (iii) The friction experienced by a body,
   when it is in motion is called _____.

(iv) The centroid of a semi-circle is at a distance of _____ from its base measured along the vertical radius (*r*).

(b) Define the following terms : $2 \times 5 = 10$

    (i) Coplanar collinear forces

    (ii) Resolution of force

    (iii) Angle of friction

    (iv) Moment of couple

    (v) Perfect frame.

(c) State the following laws : $2 \times 3 = 6$

    (i) Polygon law of forces

    (ii) Varignon's principle of moment

    (iii) Newton's second law of motion.

2.   *(a)* State and prove the parallelogram law of forces. $2 + 3 = 5$

    (b) The resultant of two forces, one of which is three times the other is $300N$. When the direction of the smaller force is reversed, the resultant is $200N$. Determine the magnitude of the forces and the angle between them.   5

(c) The following forces act a point :

    (i)   60N inclined at 30° towards North of East.

    (ii) 30N towards North.

    (iii) 40N inclined at 40° towards North of West.

    (iv) 50N inclined at 45° towards South of West.

Find the magnitude and direction of the resultant using Graphical Method.   5

(d) Find the magnitude and direction of resultant of the following force system.   5
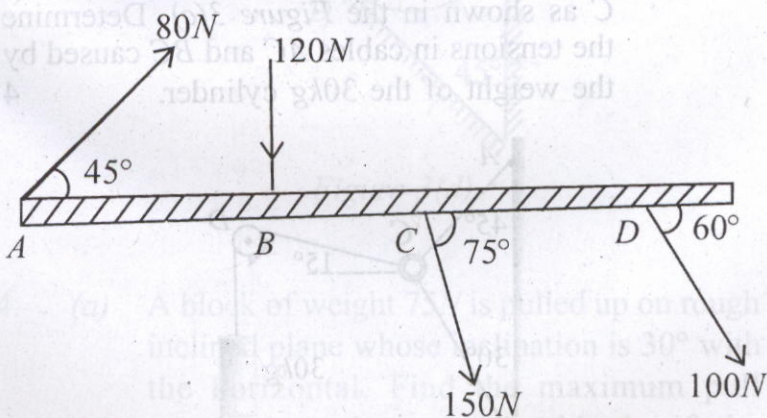

Figure 2(d)

3. (a) What is free body diagram ? What are the conditions of equilibrium of a body ?

$1+2=3$

(b) A right circular roller of weight 700N rest on a smooth horizontal floor and is kept in position with a string. Determine the tension in the string and floor reaction if there is a pull of 200N.
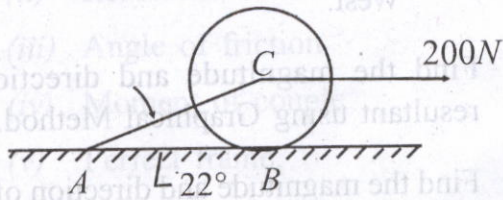
3

Figure 3(b)

(c) Three cables are joined at the junction ring C as shown in the *Figure 3(c)*. Determine the tensions in cables AC and BC caused by the weight of the 30kg cylinder.
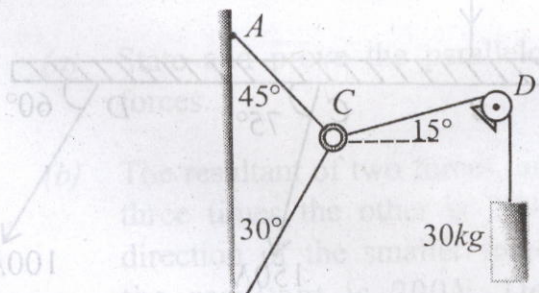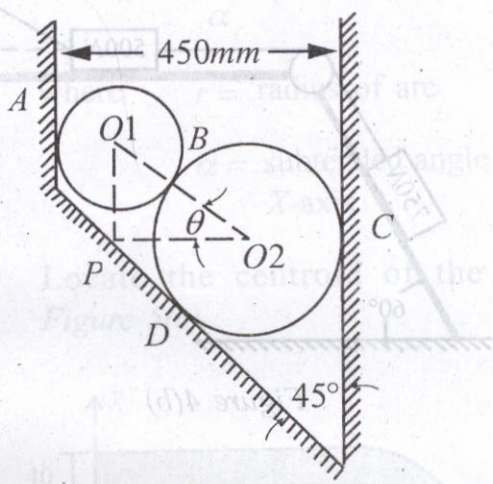
4

Figure 3(c)

53 (ME 201) ENMC/G   4

(d) Cylinder 1 of the diameter 200*mm* and cylinder 2 of diameter 300*mm* are placed in trough as shown if *Figure 3(d)*. If the cylinder 1 weighs 800*N* and cylinder 2 weighs 1200*N*, determine the reactions developed at the contact surfaces *A, B, C* and *D*. Assume all the points of contact are smooth.   10

Figure 3(d)

4. *(a)* A block of weight 75*N* is pulled up on rough inclined plane whose inclination is 30° with the horizontal. Find the maximum pull required to draw up the block, if the coefficient of friction between the block and the plane is 0·3.   4

(b) What is the value of force 'P' in the system shown in the *Figure 4(b)* to cause the motion of 500N block to the right side ? Assume the pulley is smooth and the coefficient of friction between the other contact surface is 0·20.   10
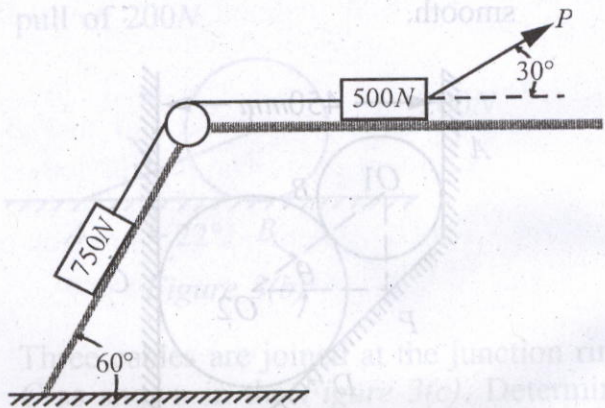
Figure 4(b)

(c) A load of 1500N, resting on an inclined rough plane, can be moved up the plane by a force of 2000N applied horizontally or by a force 1250N applied parallel to the plane. Find the inclination of the plane and the coefficient of friction.   6

5. (a) Distinguish between the centre of gravity and centroid. What do you mean by centroidal axis ? How many centroid a body has ?
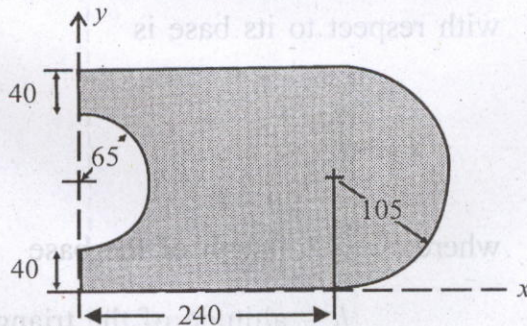
2+1+1=4

(b) Prove that the centroid of a circular arc is

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

where r = radius of arc

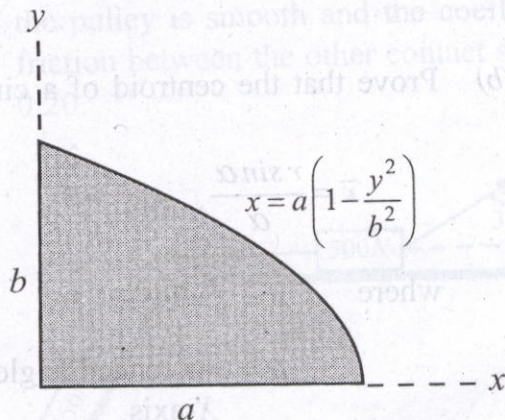 α = subtended angle of arc with X-axis   3

(c) Locate the centroid of the following Figure 5(c).   8

Dimensions in millimeters

Figure 5(c)

(d) Find the X-co-ordinate of the centroid of the shaded area as shown in *Figure 5(d)*.   5

$$x = a\left(1 - \frac{y^2}{b^2}\right)$$

Figure 5(d)

6. *(a)* Show that the moment of inertia of a triangle with respect to its base is   5

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

where, b = length of the base

h = altitude of the triangle

(b) Determine the moment of inertia of the following *Figure 6(i)* about the x_0-and y_0-centroidal axes and *Figure 6(ii)* with respect to x-and y-co-ordinate axes.   8+7=15
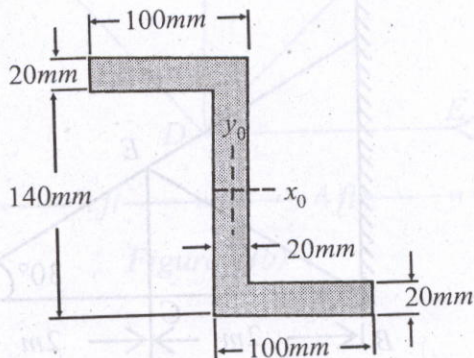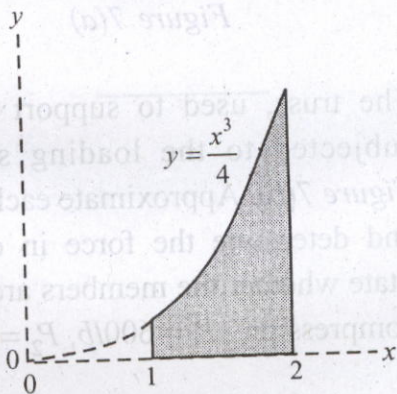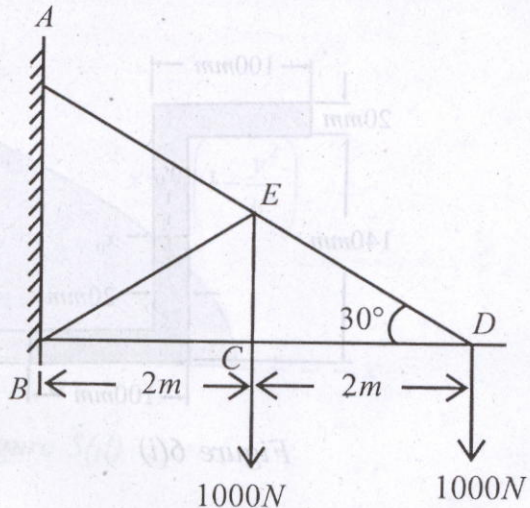

Figure 6(i)

Figure 6(ii)

Contd.

7. (a) For the plane truss AEDCB shown in Figure 7(a), determine the induced axial forces in members AE, BE and BC.　　6

Figure 7(a)

(b) The truss, used to support a balcony, is subjected to the loading shown in the Figure 7(b). Approximate each joint as a pin and determine the force in each member. State whether the members are in tension or compression. $P_1 = 600 lb$, $P_2 = 400 lb$.　　10

6.

Figure 7(b)
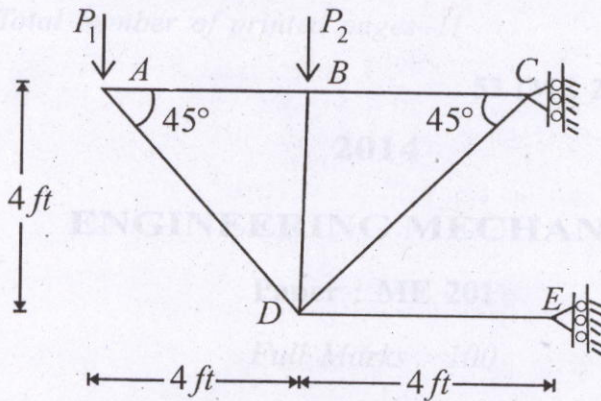
(c) What do you mean by 'deficient' and 'redundant' frames ? 2+2=4