53 (ME 201) ENMC

2016

ENGINEERING MECHANICS

Paper : ME 201

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1.   *(a)*   State the following laws :   1×3=3

      (i)   Newton's second law of motion

      (ii)   Triangular law of force

      (iii)   Parallelogram law of force.

  (b)   Two forces of magnitude 240N and 200N are acting at a point on a body. If the angle between the forces is 60° , determine the magnitude of the resultant force using —   2+2=4

      (i)   Triangular law of force

      (ii)   Parallelogram law of force.

Contd.

(c) The four coplanar forces are acting at a point as shown in the *Figure-1(c)*. One of the forces is unknown and its magnitude is shown by P. The resultant is having a magnitude of $500N$ and is acting along X-axis. Determine the unknown force 'P' and its inclination with X-axis.   8
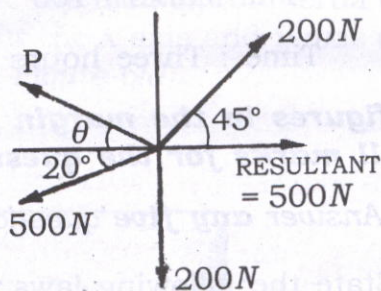

Figure-1(c)

(d) A beam of length $10m$ is simply supported over a span of $8m$ with an overhung of $2m$ on the right. The beam carries point loads of $5N$, $4N$ and $3N$ at distances of $2m$, $5m$ and $10m$ respectively from the left hand support. Determine the reaction at the supports.   5

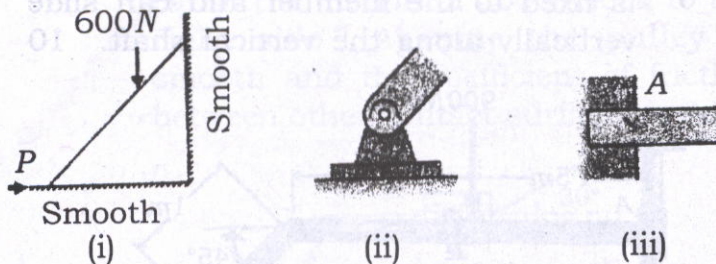2. (a) Draw Free Body Diagram of the following figures. 1×3=3

(i) (ii) (iii)

Figure-2 (a)

(b) Two smooth cylinders of weights P and Q are placed in a smooth trough as shown in *Figure-2(b)*. Determine the reactions at contact surfaces A, B and C. The following numerical data are given : 7

$P = 200N$ and $Q = 800N$;

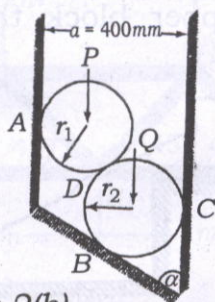$r_1 = 100mm$, $r_2 = 200mm$;

$a = 400mm$; $\alpha = 45°$

Figure-2(b)

(c) Determine the support reactions on the member in *Figure-2(c)*. The collar at *A* is fixed to the member and can slide vertically along the vertical shaft. **10**
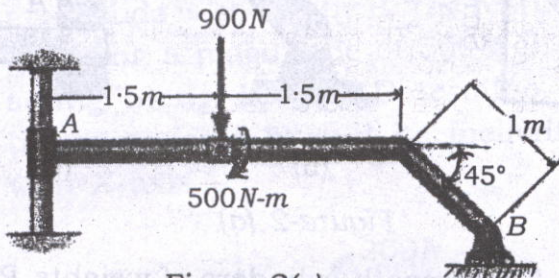

Figure-2(c)

3. *(a)* What are the coefficient of friction and angle of friction ? $1+2=3$

(b) Two blocks having weights W_1 and W_2 are connected by string and rest on a horizontal planes as shown in *Figure-3(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. **10**
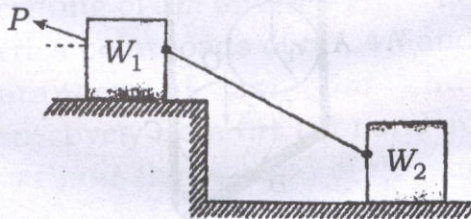

Figure-3(b)

(c) What is the value of force 'P' in the system shown in the *Figure-3(c)* to cause the motion of 500N block to the right side ? Assume the pulley is smooth and the coefficient of friction between other contact surfaces is 0·20.
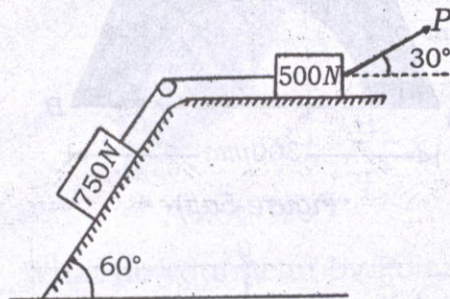
7

Figure-3(c)

4. Determine the force in each member of the truss applying methods of joint and state if the members are in tension or compression.
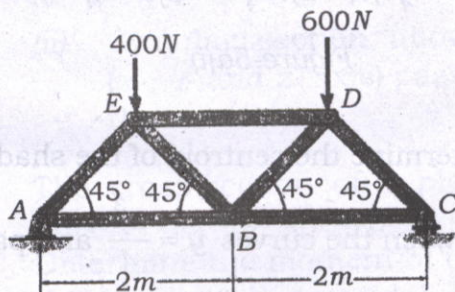
20

Figure-4

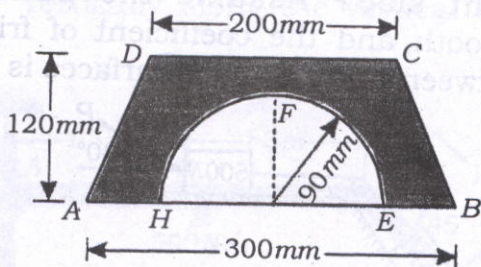5. *(a)* Determine the co-ordinates of the centroid of the shaded area of the following figures : 6+6=12
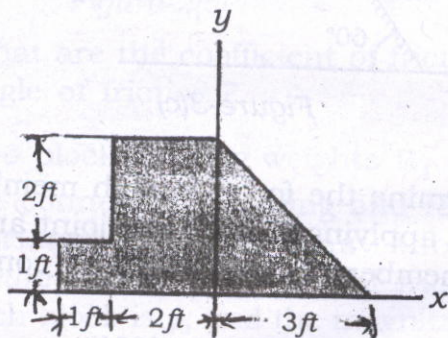

Figure-5a(i)

Figure-5a(i)

(b) Determine the centroid of the shaded area between the curves $y = \dfrac{x^3}{4}$ and parabola,

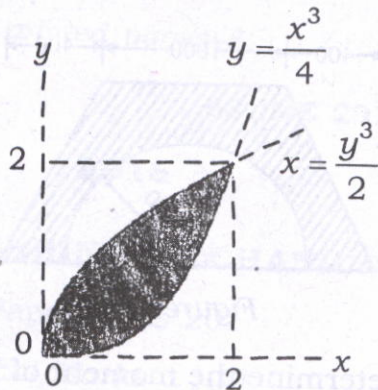$x = \dfrac{y^3}{2}$ as shown in *Figure-5(b)*. 8

y

$y = \dfrac{x^3}{4}$

2

$x = \dfrac{y^3}{2}$

0

0   2 x

Figure-5b

6. *(a)* What do you mean by Polar moment of inertia ? State the parallel axis theorem of moment of inertia.   1+2=3

(b) Derive an equation for the moment of inertia of the following sections :

                                        2+4=6

     (i) Rectangular section w.r.t. its base.

     (ii) Circular section about the axes (x-, y- and z- axis) passing through the centre.

(c) The cross-section of a plain concrete culvert is as shown in *Figure-6(c)*. Determine the moment of inertia about the horizontal centroidal axes.   5

Figure-6(c)

(d) Determine the moment of inertia of the area about the x-axis and y-axis of the following Figure-6(d). 6

Figure-6(d)