[3 Hours]   **[Marks: 80]**
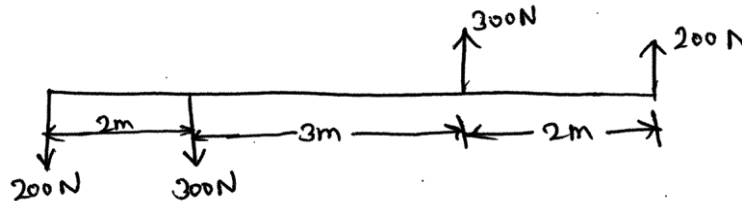
N.B: 1. Question No. **1 is compulsory**.
          2. Attempt any **three** questions out of remaining **five** questions.
          3. Assume **suitable** data if necessary stating them clearly.
          4. Take $g = 9 \cdot 81$ m/s^2.
          5. Draw suitable sketches wherever necessary.
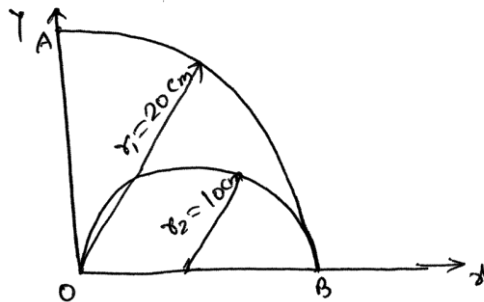
1.   Attempt **any four** :

(a) State and prove varignones theorem.   **05**

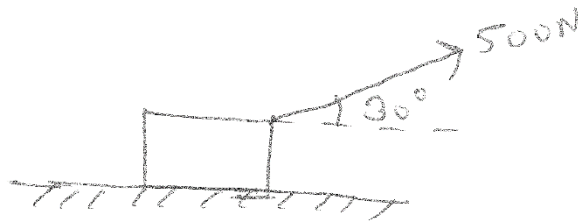(b) Find the resultant of the force system shown in fig.   **05**

(c) Find the co-ordinate of the centroid of the area shown in fig.   **05**

All dimensions are in cm

(d) A force of 500N is acting on a black of 50Kg mass resting on a horizontal surface as   **05**
     shown in fig. Determine the velocity after the block has travelled a distance of 10m.
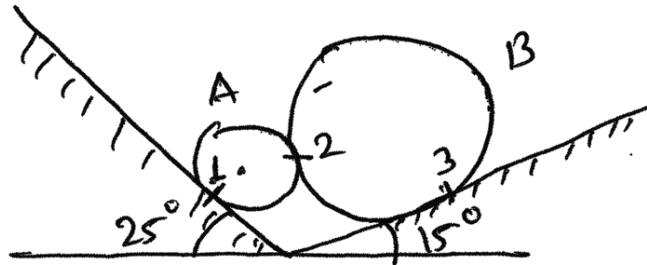   Coeff. of kinetic friction $= 0 \cdot 5$

(e) The position vector of a particle which moves in the X-Y plane is given by   **05**
     $\bar{r} = (3\,t^3 - 4t^2)i + (0 \cdot 5\,t^4)\,J$ m. Calculate velocity and acceleration at $t = 1$ sec.

2. (a) Find the resultant of the force acting on the bell crank level shown. Also locate its   **08**
        position write hinge B.
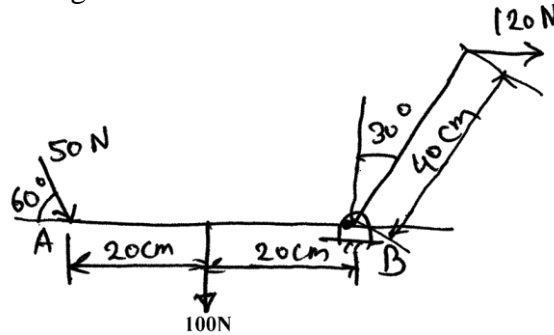
    (b) Determine the reaction at points of constant 1, 2 and 3. Assume smooth surfaces.   **05**


$$W_A = 1 \, kg, \quad r_A = 1 \, cm$$
$$W_B = 4 \, kg, \quad r_B = 4 \, cm.$$

    (c) Two balls having 20Kg and 30Kg masses are moving towards each other with velocities   **06**
        of 10m/s and 5m/s respectively as shown in fig. If other impact the ball having 30Kg
        mass is moving with 6m/s velocity to the right then determine the coefficient of
        restitution between the two balls,

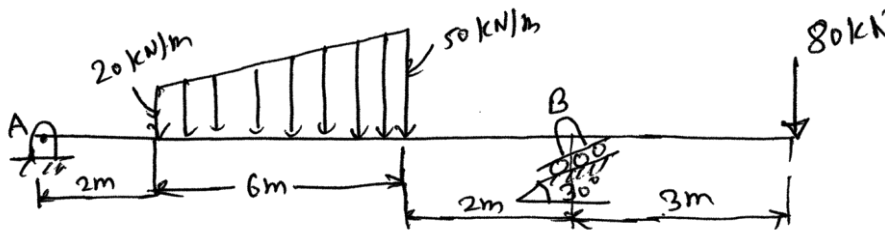3. (a) Determine the centroid of the plant lamina shaded portion is removed.   **08**
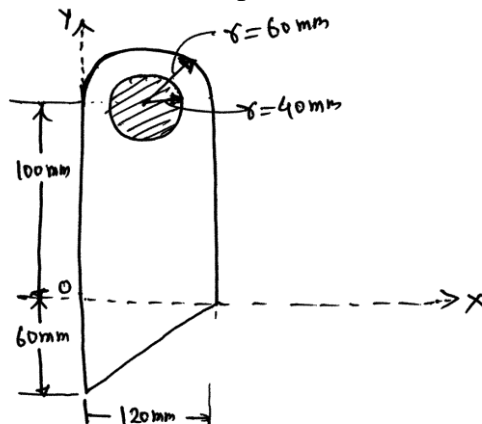
   (b) Explain conditions for equilibrium for forces in spaces.   **06**

(c) A 30N block is released from rest. If slides down a rough incline having coefficient of friction 0·25. Determine the maximum compression of the spring.   **06**
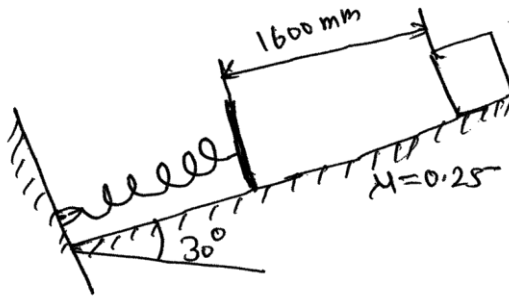

4. (a) Find the support reaction at A and B for the beam loaded as shown in fig.   **08**

(b) The V-X graph of a rectilinear moving particle is shown. Find acceleration of the particle at 20m, 80m and 200m.   **06**
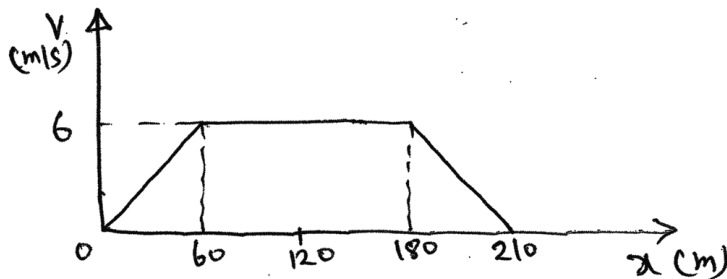

(c) A bar AB 2m long slides down the plane as shown. The end A slides on the horizontal floor with a velocity of 3m/s. Determine the angular velocity of the rod AB and the velocity of end B for the position shown.   **06**
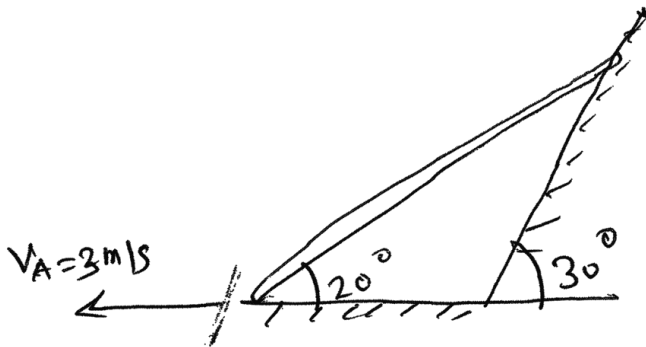
5.   (a)   Referring to the trus shown in fig. Find   **08**
         i.   Reaction at D and C
         ii.   Zero Force members
         iii.   Forces in members FE & DC by method of section.
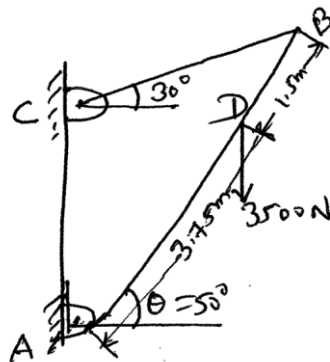   iv.   Forces in other members by method of joints.
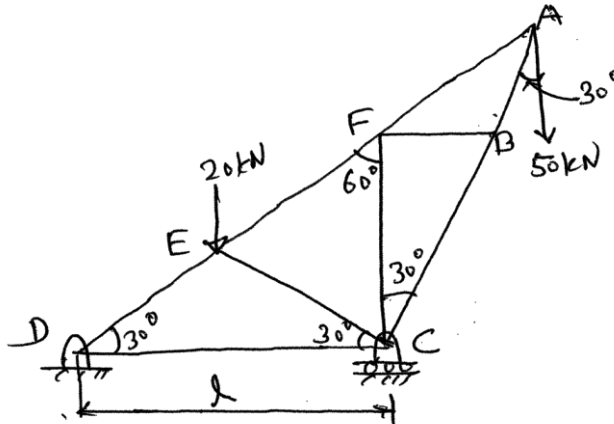
   (b)   Determine the force 10 required to move the block A of 5000N weight up the inclined   **06**
plane, coefficient of friction between all contact surfaces is 0·25. Neglect the weight of
the wedge and the wedge angle is 15 degrees.
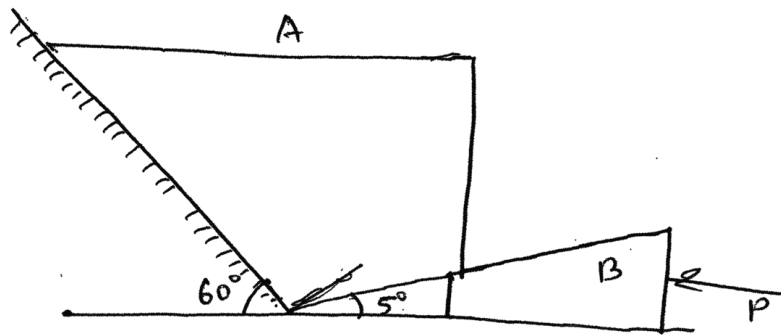
   (c)   Determine the tension in a cable BC shown in fig by virtual work method.   **06**

6. (a) A 500N Crate kept on the top of a 15° sloping surface is pushed down the plane with **05**
    an intitial velocity of 20 m/s. If $\mu s = 0{\cdot}5$ and $\mu \kappa = 0{\cdot}4$, Determine the distance travelled
    by the block and the time it will take as it comes to rest.

  (b) Derive the equation of the path of a prosotile and hence show that the path traced by a **05**
    prosectile is a parabolic curve.

  (c)   **05**
    A particle is moving in X-Y plane and its position is defined by $\bar{r} = \left(\dfrac{3}{2}t^2\right)i + \left(\dfrac{2}{3}t^3\right)J$.

    Find ratio of curvature when $t = 2$ sec.

  (d) A force of 100N acts at a point $P(-2, 3, 5)$ m has its line of action passing through Q **05**
    (10, 3, 4) m. Calculate moment of this force about origin (0,0,0).

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