PRN-1 (2015) (Engineering Mechanics)   (Problems Sheet)
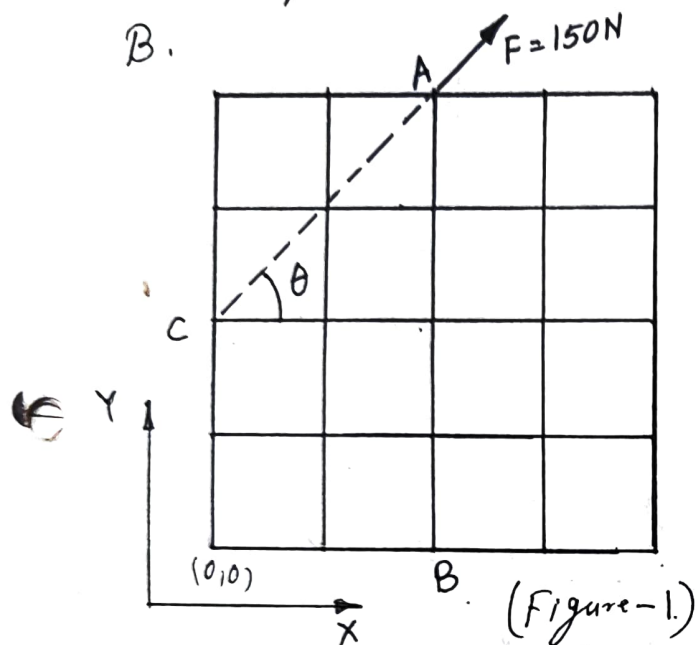3/8/15

VECTORS

Prob-1. The rectangular plate as shown in Figure is made up of 0.3 m sized squares. A 150-N force is applied at the point- A. Calculate moment of force about the point B.

[Ans: $\vec{M} = 127.28\,\hat{k}$, N-m]

(Figure-1.)

Prob-2 A force $\vec{F_1} = (10\,\hat{i} + 6\,\hat{j} + 3\,\hat{k})$ N acts at a position $(3, 0, 2)$. At point $(0, 2, -3)$ and equal but opposite force $-\vec{F_1}$ acts. What is the couple moment? What are the direction cosines normal to the plane of the couple? Assume that the co-ordinates are given in metre. (fig-2).
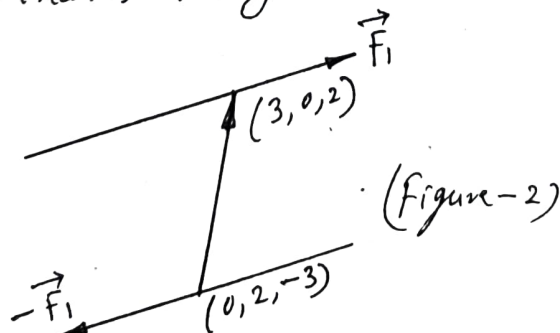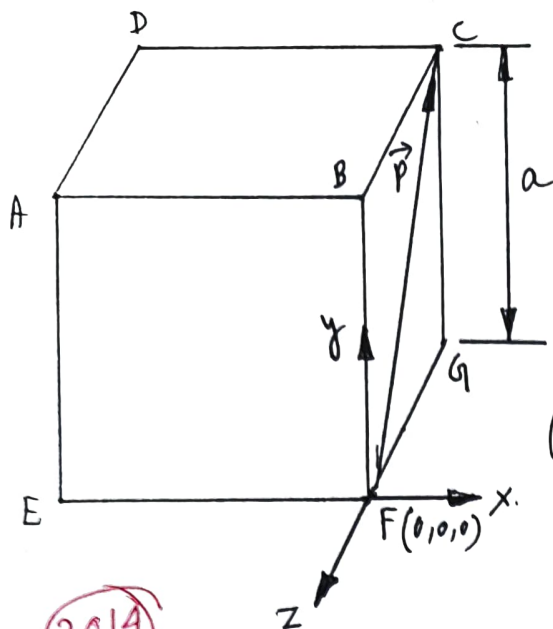

(Figure-2)

[Ans: $l = -0.541$
$m = 0.617$
$n = 0.571$]

(2014)

Prob-3 A cube of side 'a' is acted upon by a force $\vec{P}$ as shown in figure-3. Determine:

(i) moment of $\vec{P}$ about the point A.

(ii) moment of $\vec{P}$ about the edges AB.

(iii) moment of $\vec{P}$ about the diagonal AG

(iv) using result of part (iii), determine $\perp^r$ distance from AG to FC

(Figure-3)

$$\left[\text{Ans:} \; (i) \; \vec{M}_A = \frac{ap}{2}(\hat{i}+\hat{j}+\hat{k}) \right.$$

$$(ii) \; |\vec{M}_{AB}| = \frac{ap}{\sqrt{2}}$$

$$(iii) \; |\vec{M}_{AG}| = -\frac{ap}{\sqrt{6}}$$

$$\left. (iv) \; \frac{a}{\sqrt{6}} \right]$$

(2014)

Prob-4 Determine the X, Y, Z Components of a 1000 kgf force passing from the origine to point (2,-4,1).

[Ans: 437 kgf, -873 kgf, 218 kgf]

(2014)

Prob-5 The x, y and z Components of a Vector $\vec{V}$ have magnitudes of 2, 2 and 1 unit respectively. Find the expression for the vector in Component form and determine the d.Cs of the vector and the Corrospon -ding angles made by the Vector with the reference axes.

$$\left[\text{Ans:} \; \left(\frac{2}{3}\hat{i} + \frac{2}{3}\hat{j} + \frac{1}{3}\hat{k}\right), \; 48.7°, \; 48.7°, \; 70.7° \right]$$

(2014)

Prob-6 A moment Vector of magnitude 100 kgf-m starts at the point (-3,0,0), and terminates at the point (0,-4,5). Find the vector expression for the moment.

$$\left[\text{Ans:} \; \vec{M} = 42.43\hat{i} - 56.57\hat{j} + 70.71\hat{k} \right]$$

Prob-7 Find the perpendicular distance from the point (1,2,3) to the line joining from the origine to the point (2,10,5)

[Ans: 1.84 units]

Prob – 8 Show that the two forces $\vec{P_1} = 2\hat{i} + 4\hat{j}$ and $\vec{P_2} = 3\hat{i} + 6\hat{j}$ are parallel.

Prob – 9 A force Vector $10\hat{i} + 25\hat{j} + 35\hat{k}$ passes through a point ($2,5,7$). Prove that the force passes through origine.

Prob – 10 The points of application of two equal forces $7\hat{i} + 11\hat{j} + 5\hat{k}$ are ($-4,5,3$) and ($3,16,8$) respectively. Calculate the moments of the two forces about the point ($-3,13,7$) and show that the force is transmissible.
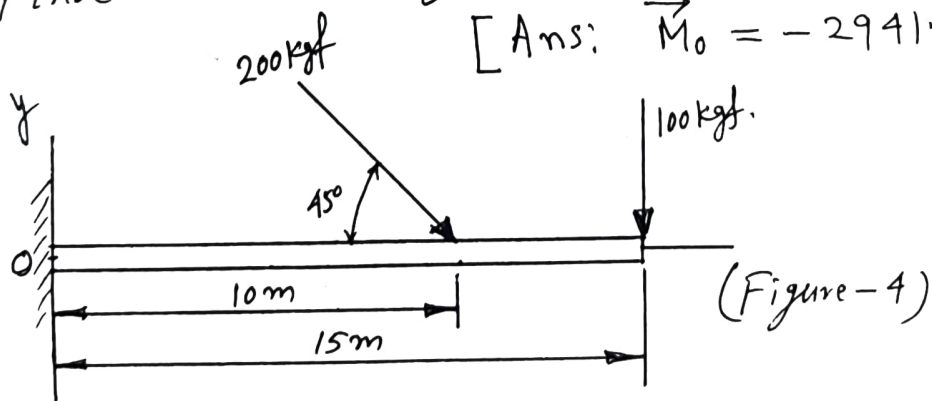
$$\left[\text{Ans: } \vec{M_1} = 4\hat{i} - 23\hat{j} + 45\hat{k}, \ \vec{M_2} = 4\hat{i} - 23\hat{j} + 45\hat{k} \right]$$

Prob – 11 A force $12\hat{i} - 24\hat{j} + 9\hat{k}$ passes through the point ($-9,24,6$). Find the moment of the force about the reference axes X, Y, and Z.

$$\left[\text{Ans: } \vec{M_x} = 360\hat{i}, \ \vec{M_y} = 153\hat{j}, \ \vec{M_z} = -72\hat{k}. \right]$$

(2014)

Prob – 12 A loaded Cantilever beam is shown in figure-4. Find the moment of the Forces about o.

$$\left[\text{Ans: } \vec{M_0} = -2941.2 \ \hat{k} \right]$$

(Figure – 4)

Prob – 13 Two equal and opposite Forces of magnitude $F = 10 kgf$ are acting on a body as shown in Figure-5. Find the moment of the Couple.

$$\left[\text{Ans: } 5\sqrt{50} \ (\hat{i} + \hat{j}) \ kgf\text{-}m \right]$$
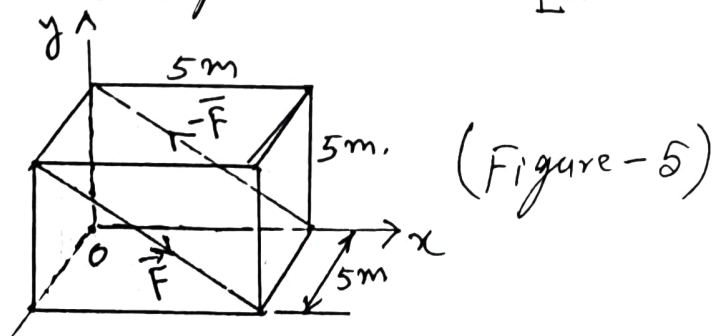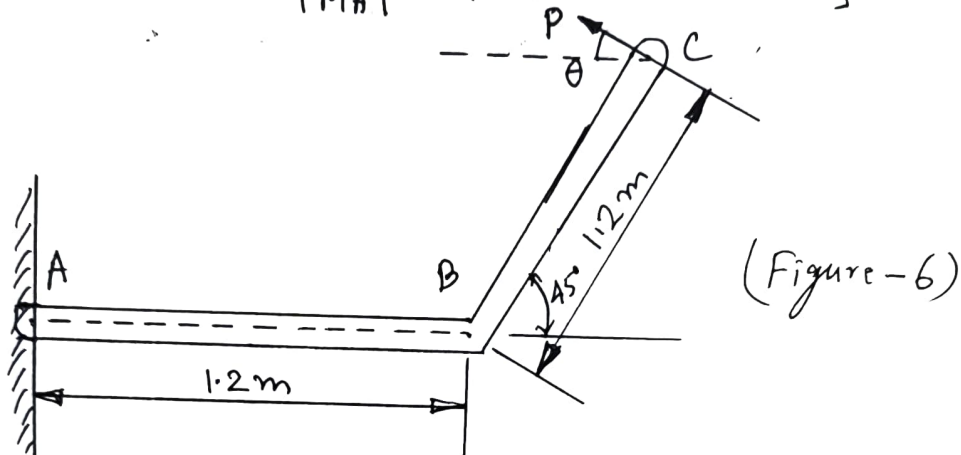

(Figure – 5)

Prob-14 A 60N force P is applied at point C of the bent bar. Determine moment of P about the point A for what Value of the angle θ will be above moment be a maximum? Determine the Corrosponding maximum Value (M_A) max.

(Figure -6)   [Ans; $\vec{M_A} = (122.91 \sin\theta + 50.91 \cos\theta)\hat{k}$, N-m

$|\vec{M_A}| = 133.04$ N-m]

(Figure - 6)

Prob-15 A force Vector of magnitude 10 kgf starts at the origine of a Certain refrence X,Y,Z and is directed away from the origine. If the direction Cosines l & m of the force are -0.6 and $+0.3$ respectively find the Vector expression of the force.

[Ans; $\vec{F} = (-6\hat{i} + 3\hat{j} \pm 7.416\hat{k})$ kgf]

Prob-16 A force whose magnitude is 10 kgf has its unit Vector $\hat{e} = 0.5\hat{i} + 0.07071\hat{j} + 0.5\hat{k}$. Determine

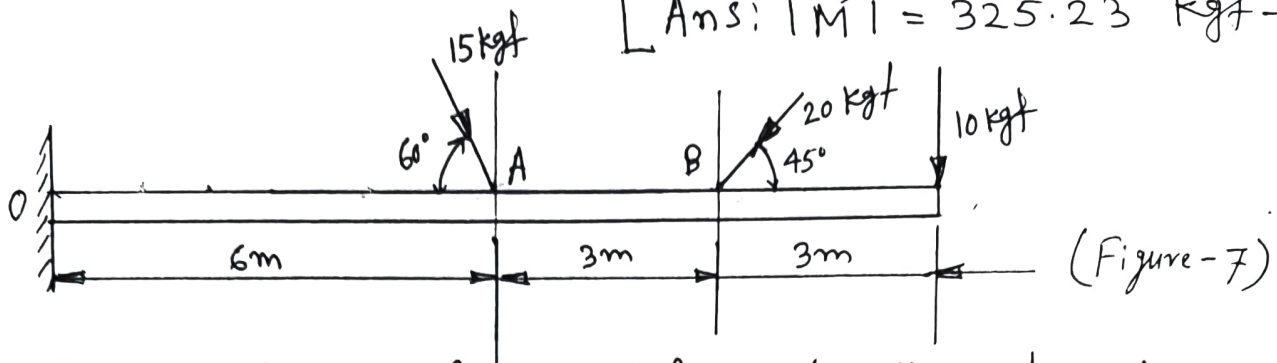(i) the force expressed in Vector form.

(ii) angles made by the force with the axes X, Y, and Z.

[Ans; (i) $(5\hat{i} + 7.071\hat{j} + 5\hat{k})$

(ii) $\alpha = 60°$, $\beta = 45°$, $\gamma = 60°$]

(Page - 5)

Prob-17 A Cantilever Beam is loaded as shown in figure-7 below. Determine the moment of forces about o.

[Ans: $|\vec{M}| = 325.23$ kgf-m]

(Figure - 7)

Prob-18 A force Vector is defined by the expression

$$\vec{F} = (9\hat{i} - 2\hat{j} + 6\hat{k}) \text{ kgf}$$

Determine the scalar following

(i) the Scalar Component of the forces.

(ii) the angle magnitude of the force

(iii) the d.c of the forces

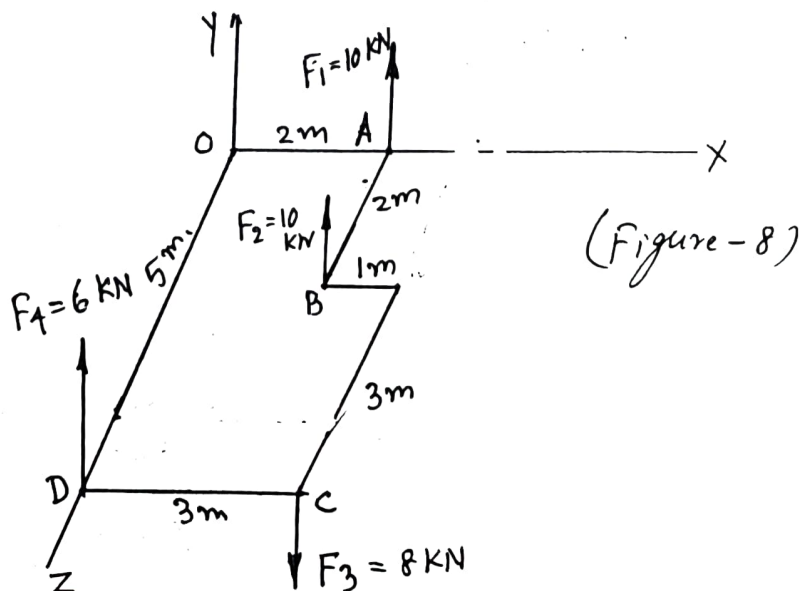(iv) the unit Vector in the direction of the force.

[Ans: (i) 9, -2, 6 kgf (ii) 11 kgf (iii) $\ell = \frac{9}{11}$, $m = -\frac{2}{11}$, $n = \frac{6}{11}$

(iv) $\hat{e} = \frac{1}{11}(9\hat{i} - 2\hat{j} + 6\hat{k})$]

Prob-19 Determine the resultant of the forces parallel to Y-axis acting on a horizontal plate as shown in Fig-8.

[Ans: 18j acting at $\frac{8}{9}\hat{i} + \frac{5}{9}\hat{j}$]

(Figure - 8)

Prob-20 A force $F = 200\,N$ holds the ~~gate~~ grate having a mass of $m = 25\,kg$ in equilibrium. If the tension along AC and AB is to be $T = 400\,N$ each. Determine the Co-ordinates of A as shown in figure-9 B and C lie on ZX plane.

[Ans; $A(0, 27.22, 46.66)$ cm]

(Figure-9)
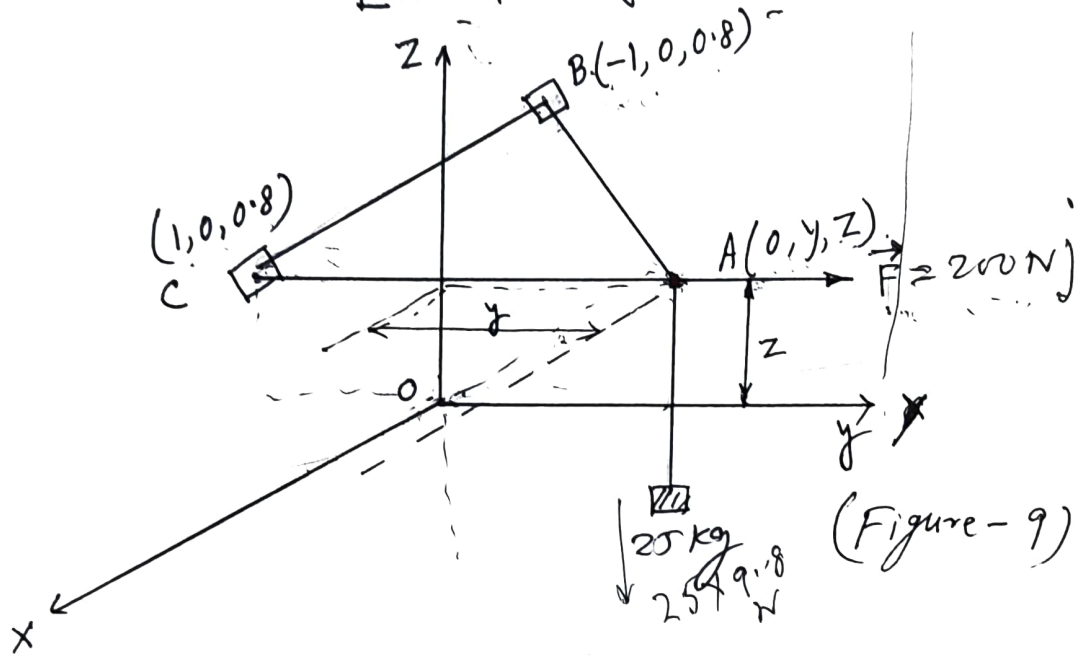
Prob-21 A force $\vec{F} = (3\hat{i} - 4\hat{j} + 12\hat{k})\,N$ acts at a point-A whose coordinates are $(1, -2, 3)\,m$. Compute

(i) moment of force about origine.

(ii) moment of force about the point-B $(2, 1, 2)\,m$.

[Ans; (i) $(-12\hat{i} - 3\hat{j} + 2k)\,N\text{-}m$

(ii) $(-32\hat{i} + 15\hat{j} + 13\hat{k})\,N\text{-}m$]

Prob-22 $F = 1000\,N$, $0(0,0,0)$, $A(0,10,0)$ and $B(5,0,4)$ Draw the diagram and calculate the moment of the force about 0.

[Ans; $5392.4\,N\text{-}m$]