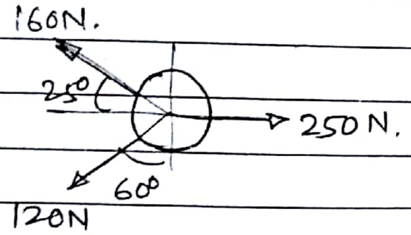
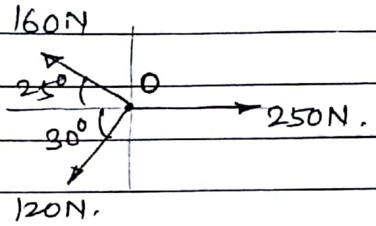
Q.1.

(a)

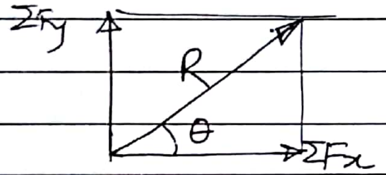




Magnitude –

$\Sigma F_x = 250 - 160\cos 25 - 120\cos 30 = 1.07\ N\ (\rightarrow)$ – ½ –

$\Sigma F_y = 160\sin 25 - 120\sin 30 = 7.62\ N\ (\uparrow)$ – ½ –



$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$

$= \sqrt{1.07^2 + 7.62^2}$

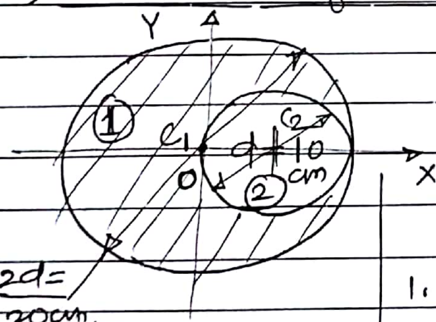
$= 7.69\ N.$ – ½ –

Direction – $\theta = \tan^{-1}(\Sigma F_y / \Sigma F_x)$

$= \tan^{-1}(7.62/1.07)$

$\therefore\ \theta = 82.01^\circ$ – ½ –

(b) Coordinates of Centroid –



∵ The lamina is symmetric about x-axis, Y-coordinate of the centroid is ZERO. — ½ –

Component	Area, A cm^2	$\bar{x}$ cm	$A\bar{x}$ cm^3
1. Bigger circle	$\frac{\pi}{4}(20)^2$ =314.16	0	0
2. Smaller circle (to be removed)(–)	$\frac{\pi}{4}(10)^2$ =78.54	5	(–)392.7

$\Sigma A = 235.62$ – ½ – $\Sigma A\bar{x} = -392.7$ – ½ –

$\therefore\ \bar{X} = \frac{\Sigma A\bar{x}}{\Sigma A} = \frac{-392.7}{235.62} = -1.67$ cm. – ½ –

∴ Coordinates of centroid, $C \equiv (-1.67, 0)$

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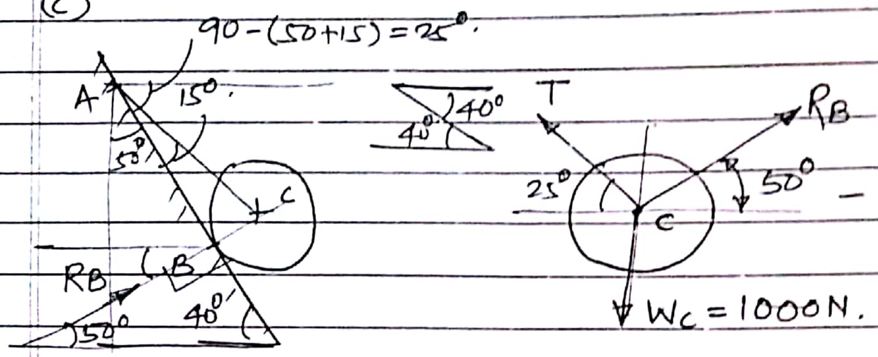
(c)



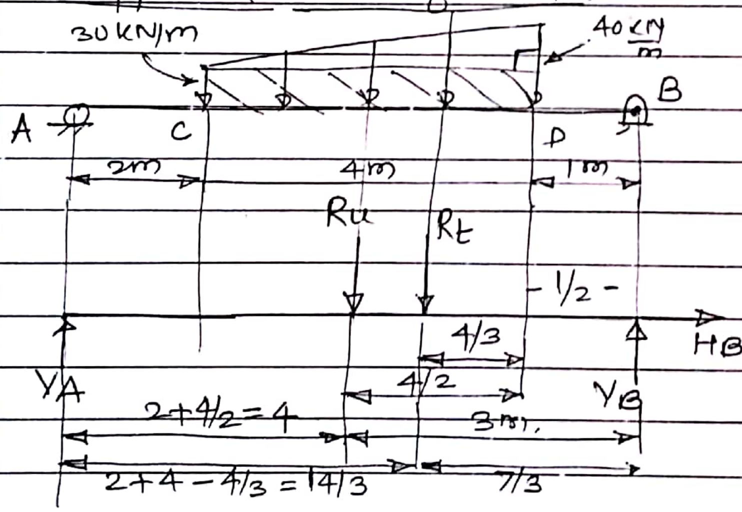
-1-

- To find T: ∵ Roller is at REST under the action of 3 forces, Lami's theorem can be used.

$$\therefore \frac{1000}{\sin(180-25-50)} = \frac{T}{\sin(90+50)}$$

$$\therefore T = \frac{1000 \cdot \sin(140)}{\sin(105)} \quad \therefore T = 665.46\ N. \quad -1-$$

(d) Support Reactions for beam -



$R_u = q \times L$
$= 30 \times 4$
$= 120\ kN$. -1/2 -

$R_t = \frac{1}{2} \times q \times L$
$= \frac{1}{2} \times (40-30) \times 4$
$= 20\ kN$. -1/2 -

$\therefore \Sigma M_B = 0 = -Y_A \times 7 + 120 \times 3 + 20 \times 7/3$

$\therefore Y_A = 406.67/7 = 58.09\ kN(\uparrow)$ -1/2 -

(e) Assumptions made during analysis of plane trusses:

i. All the members are straight and are of uniform cross-section

ii. All the members are 2-force members only.

iii. The loads are acting at the joints only. -1/2- each

iv. All the joints are pin-connections only. for a point.

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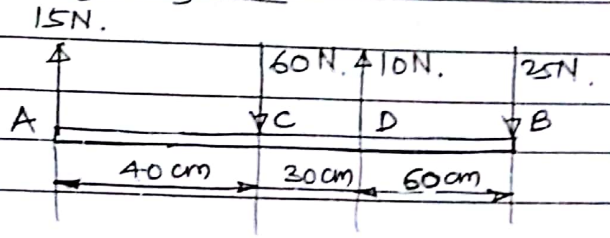
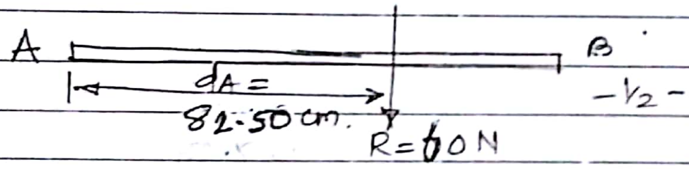
(f) To replace the given system of parallel forces with a single force:



$\Sigma F_y = 15 - 60 + 10 - 25$
$R \quad = -60\,N$
$R = 60\,N(\downarrow)$ — ½ —

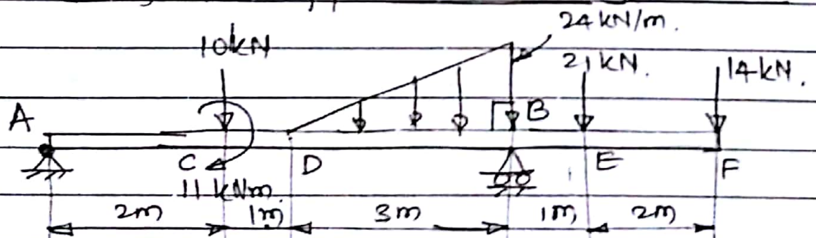
$\Sigma M_A = -60\times40 + 10\times70 - 25\times130$
$= -4950\,Nm = 4950\,Nm$ (↻) — ½ —
$= M_A^R$
$= R \times d_A$
$\therefore\ d_A = 4950/60 = 82.50\,cm.$ — ½ — 82.5

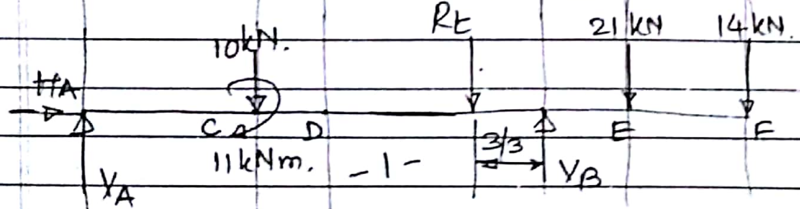


— ½ —

Q.2.

(a) To find support reactions for a beam:





$R_t = \frac{1}{2}\times24\times3$
$= 36\ kN.$
— 1/2 —

$\Sigma M_A = 0 = -10\times2 - 11 - 36\times(6 - 3/3) + 6V_B - 21\times7 - 14\times9$

$\therefore\ V_B = 80.67\,KN(\uparrow)$ — 2 —

$\Sigma F_y = 0 = V_A + V_B - 10 - 36 - 21 - 14$

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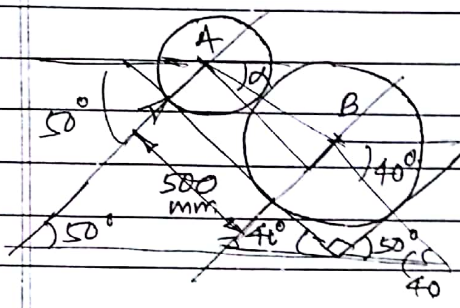
$\therefore\ V_A + V_B = 81$

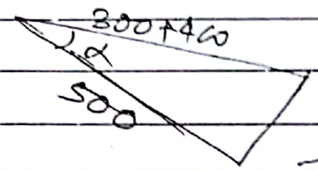
$\therefore\ V_A = 81 - 80.67 = 0.33\ kN\ (\uparrow)$ — 1 —

$\Sigma F_x = 0 = H_A$

$\therefore\ H_A = 0.$ — ½ —

(b) Finding contact reactions -

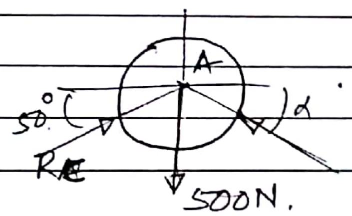


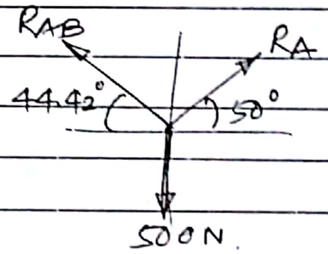


— 1 —

$\cos\alpha = \frac{500}{700}\ \therefore\ \alpha = 44.42°$

FBD of roller 'A'



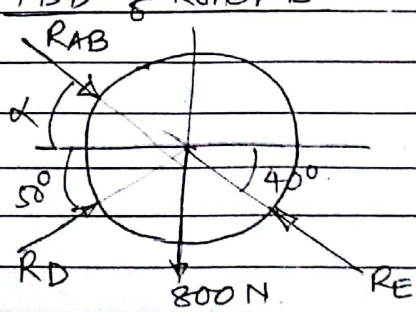


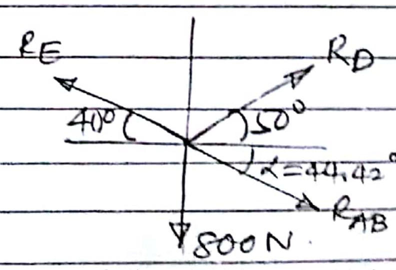
$$\frac{500}{\sin(180 - 44.42 - 50)} = \frac{R_E}{\sin(90 + 44.42)} = \frac{R_{AB}}{\sin(90+50)}$$

698.14 $\quad R_E = \frac{500 \times \sin 134.42}{\sin 85.58}$ ~~= 358.18 N.~~ — 1

322.35 $\quad R_{AB} = \frac{500 \times \sin 140}{\sin 85.58}$ ~~= 322.35 N.~~ — 1 —

FBD of Roller B





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$\Sigma F_x = 0 = R_D \cos 50 - R_E \cos 40 + R_{AB} \cos 44.42$

$\therefore 0.643 R_D - 0.766 R_E = -230.23$

$\Sigma F_y = 0 = R_D \sin 50 + R_E \sin 40 - R_{AB} \sin 44.42 - 800$

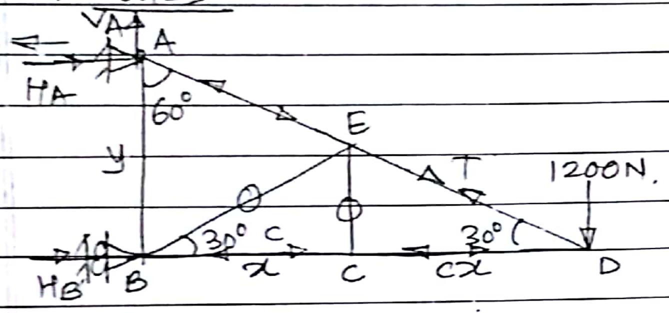
$\therefore 0.766 R_D + 0.643 R_E = 1025.62$

458.69 $\therefore R_D = 637.46$ N —1—

736.20 and $R_E = 835.66$ N. —1—

Q. 3.

(a) Truss -



To find support reactions

$\Sigma M_A = 0$

$\tan 30 = \frac{y}{2x}$

$\therefore y = 1.155x$.

$\therefore \Sigma M_A = H_B \times y - 1200 \times 2x$

$\therefore H_B = \frac{2400x}{1.155x}$

$\therefore H_B = 2078.46$ N. $(\rightarrow)$

— 1M

$\Sigma F_x = 0 = H_A + H_B$

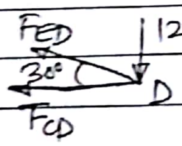
$\therefore H_A = -2078.46$ N $= 2078.46$ N $(\leftarrow)$ — $\frac{1}{2}$M

$\Sigma F_y = 0 = V_A - 1200$

$\therefore V_A = 1200$ N $(\uparrow)$. — $\frac{1}{2}$M

To find the forces in members of truss - (MOJ)

(i) Joint 'D' - $\frac{3}{4}$M for each force $= \frac{3}{4} \times 4 = 3$M



$\Sigma F_y = 0 = -1200 + F_{ED} \cdot \sin 30$

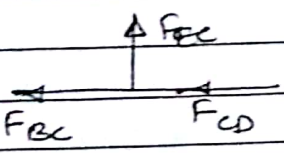
$\therefore F_{ED} = 2400$ N (T)

$\Sigma F_x = 0 = -F_{CD} - F_{ED} \cos 30$

$\therefore F_{CD} = -2400 \times \cos 30 = -2078.46$ N

$\therefore F_{CD} = 2078.46$ N (C)

(ii) Joint 'c'



$\Sigma F_y = 0$

$\therefore F_{EC} = 0$.

$\Sigma F_x = 0 = -F_{BC} - F_{CD}$

$\therefore F_{BC} = -F_{CD} = -2078.46$ N

$\therefore F_{BC} = 2078.46$ N (C).

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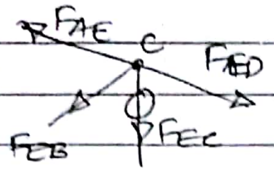
(iii) Joint 'C' — By inspection



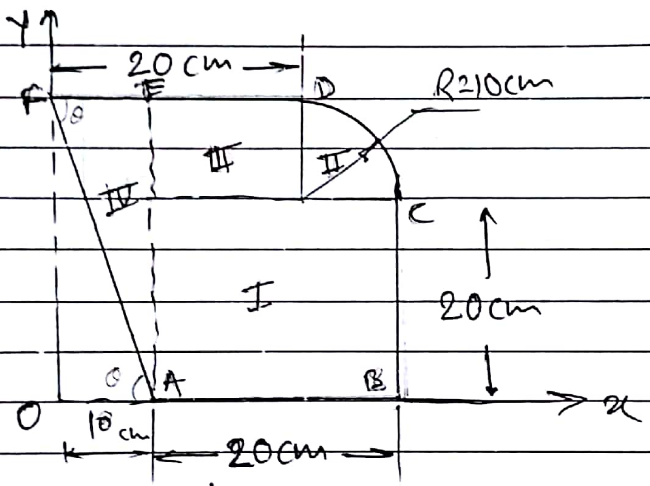
$F_{EB} = 0.$

and

$F_{AE} = F_{ED} = 2400\,N\,(T).$

Q 3

(b) Locate the centroid.



Part	Area (cm²)	xi (cm)	Yi (cm)	Aixi (cm³)	AiYi (cm³)
Square	400 cm²	20	10	1M 8000	4000
Qtr Circle	78.53 cm²	24.24	24.24	1M 1903.56	1903.56
Rectangle	100 cm²	15	25	1M 1500	2500
Triangle	150 cm²	6.668	20	1M 1000.2	3000.4

$\Sigma A_i = 728.52\ cm^2$

$\Sigma A_i x_i = 12403.24\ cm^3$

$\Sigma A_i y_i = 11403.21\ cm^3$

$\bar{x} = \frac{\Sigma A_i x_i}{\Sigma A_i}$ $\quad\quad$ $\bar{Y} = \frac{\Sigma A_i Y_i}{\Sigma A_i}$

$= 17.025\ cm$ $\frac{1}{2}$M $\quad\quad$ $= 15.652\ cm$ $\frac{1}{2}$M

Centroid (17.025, 15.650)

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