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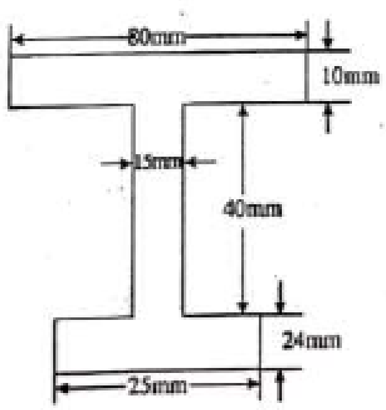
Internal Assessment Test II – Sep. 2021

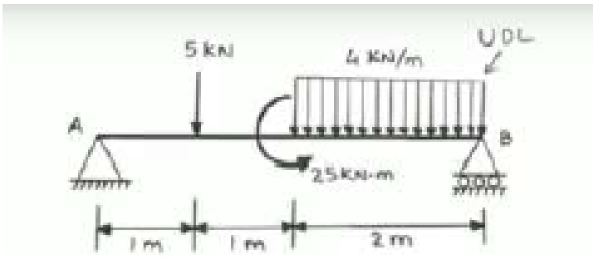
Sub:	Elements of Civil Engineering and Mechanics					Sub Code:	18CV24	Branch:	Civil Engg
Date:	06.09.2021	Duration:	90 min's	Max Marks:	50	Sem / Sec:	2nd sem /O section		OBE

Answer any FIVE FULL Questions

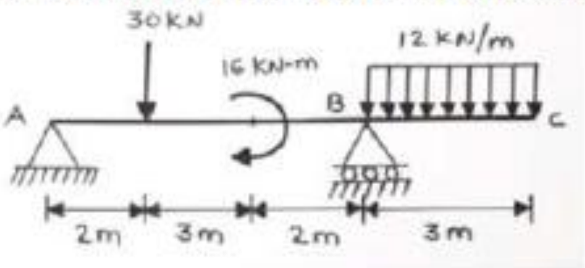
		MARKS	CO	RBT
1 (a)	Define centroid and center of gravity, list their differences?	[03]	CO4	L1
(b)	Derive an expression to locate the centroid of Triangular lamina.	[07]	CO4	L2
2 (a)	Locate the centroid of the given I-section with respect to the base of flange of 25 mm width.	[10]	CO4	L3



3 (a)	Determine the support reactions of the beam as shown in below figure	[10]	CO3	L3



4 (a)	Determine the support reactions of the beam as shown in below figure.	[02]	CO3	L3



5) (a)	Find the forces in all the members of the truss shown in figure by using method of joint. Indicate the forces on the truss with their nature.	[10]	CO3	L3

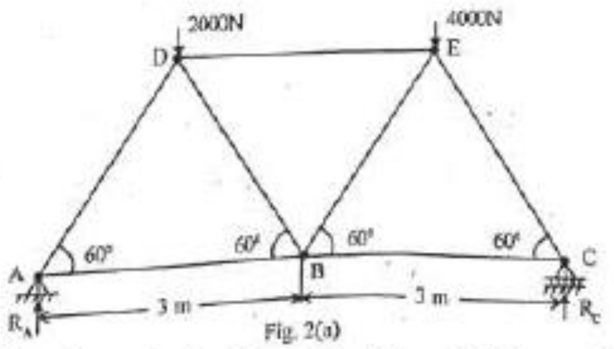
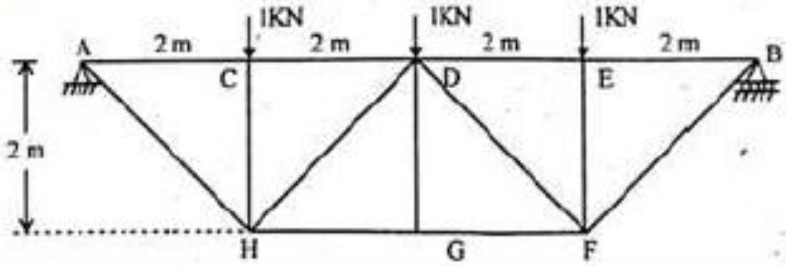


Fig. 2(a)

6) (a) A truss is loaded as shown in the figure. Find the axial forces in the members CD, DH and GH. [10] CO3 L3



IAT- 2

Civil

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Date :- 06/09/21

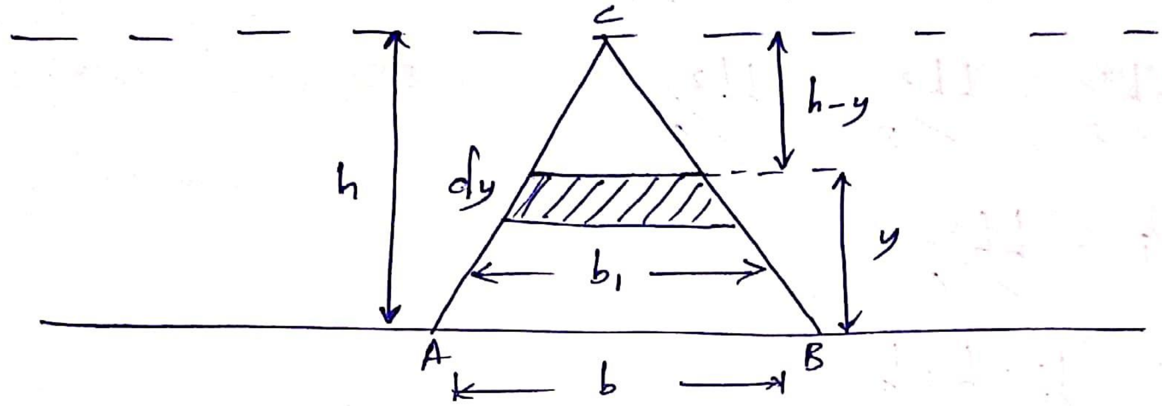
1a) Centroid:- The point at which the total area of the plane fig. is assumed to be concentrated at the centre.

Center of gravity:- Centre of gravity of a body is a point through which the whole weight of the body pass through it for any of its orientation.

Centre of gravity	Centroid
→ The point where the total weight of the body focuses upon.	→ It is refered to the geometrical centre of the body.
→ It is the point where the gravitational force (weight) acts on the body.	→ It is referred to the centre of gravity of uniform density objects.
→ It is denoted by g.	→ It is denoted by C.
→ It is a physical behaviour of the object, a point where all the weight of an object is acting.	→ It is a geometrical behaviour. It is the centre of measure of amt. of geometry.

1b) To ~~loc~~ locate centroid of a triangular lamina using first.

Principle :- Consider a triangular lamina ABC of area $\frac{1}{2}bh$ as shown in fig:



Now consider an elemental stripe of area of $\cdot(b_1 x dy)$ at a distance of y from AB (Base). Using property of similar Δ^{les},

$$b/h = b_1/h-y$$

$$b_1 = b(h-y)/h$$

Area of elemental strip is given by $b_1 x dy$

$$= \frac{(h-y)b}{h} dy$$

Moment of area of elemental strip about

$$AB = \text{Area} \times y$$

$$= \frac{(h-y)}{h} b \times dy \times y.$$

$$= \frac{b \times h \times dy \times y}{h} - \frac{y \times b \times dy \times y}{h}$$

$$= b \times y \times dy - \frac{y^2 \times b \times dy}{h}$$

Now area of the whole Δ^{le} is

$$\int_0^h b \times y \times dy - \int_0^h y^2 b/h \, dy$$

$$= b\left[\frac{y^2}{2}\right]_0^h - \frac{b}{h}\left[\frac{y^3}{3}\right]_0^h$$

$$= \frac{bh^2}{2} - \frac{bh^2}{3} = \frac{bh^2}{6}$$

$$\Sigma a_i y_i = \frac{bh^2}{6}$$

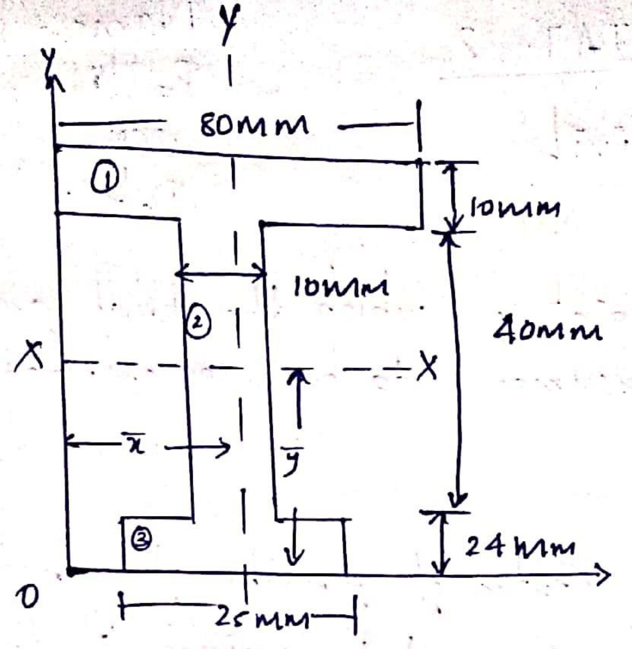
$$\Sigma a_i = \frac{1}{2} \times b \times h$$

$$\bar{y} = \frac{\Sigma a_i y_i}{\Sigma a_i} = \frac{bh^2/6}{\frac{1}{2} \times b \times h} = h/3$$

$$\boxed{y = h/3} \qquad \text{ILY} \qquad \boxed{\bar{x} = b/3}$$

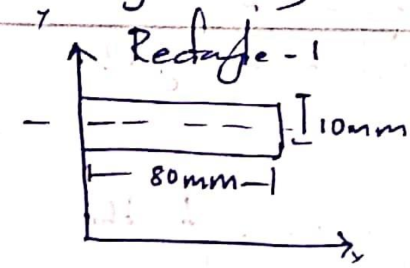
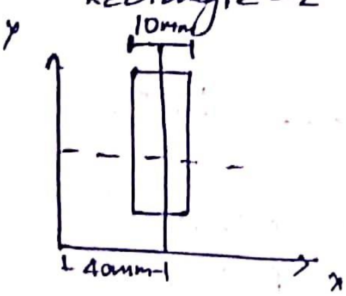
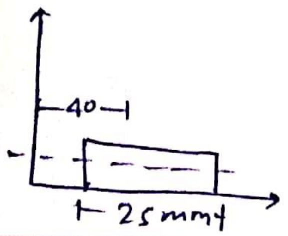
From the base $\bar{y} = h/3$
From the apex is $\bar{y} = 2h/3$

2a)



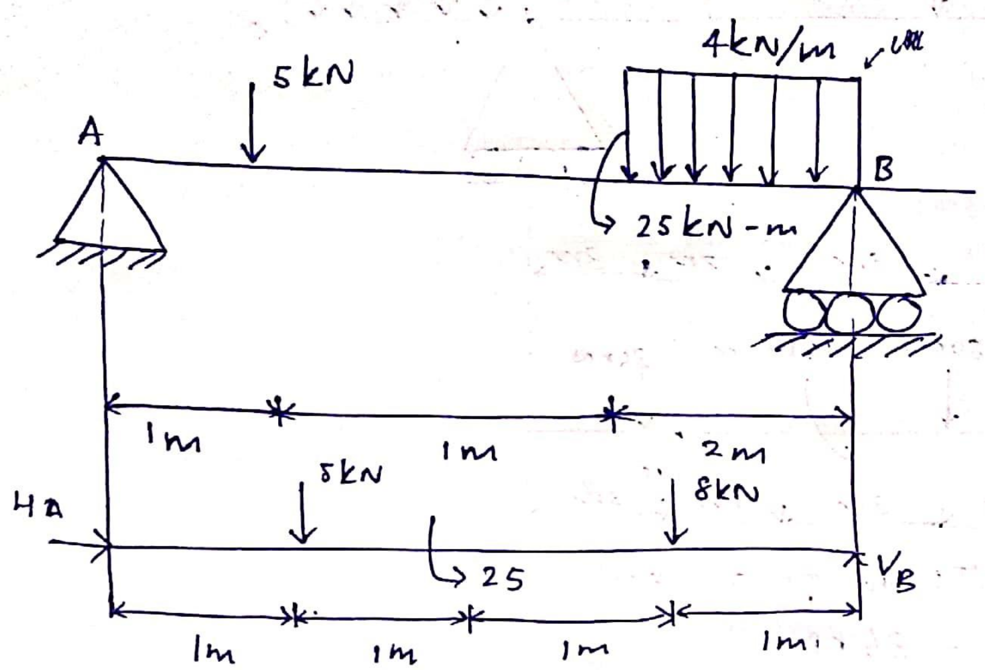
$\bar{X} = 80/2 = 40mm$

As the given geometry is symmetric about mid vertical axis.

Geometry	Area (a_i)	$\bar{y}_i$	$a_i y_i$
Rectangle - 1 	10×80 $= 800$	$24 + 40 + 10/2$ $= 69$	55,200
Rectangle - 2 	15×40 $= 600$	$24 + 40/2$ $= 44$	26,400
Rectangle 3 	25×24 $= 600$	$24/2 = 12$	7200
	$\Sigma a_i = 200$		

$$\bar{y} = \Sigma a_i y_i / \Sigma a_i = 88800/2000 = 44.44 \text{ mm}$$

3)



UDL to point load

P = 4 × 2 = 8kN at middle (i.e in from A)

By the conditions of equilibrium

$\Sigma F_x = 0$

$\boxed{H_A = 0}$

$\Sigma F_y = 0$

$V_A + V_B - 5 - 8 = 0$

$V_A + V_B = 13 \rightarrow (1)$

$\Sigma M_A = 0$

$5 \times 1 - 25 + 8 \times 3 - V_B \times 4 = 0$

$5 - 25 + 24 = V_B \times 4$

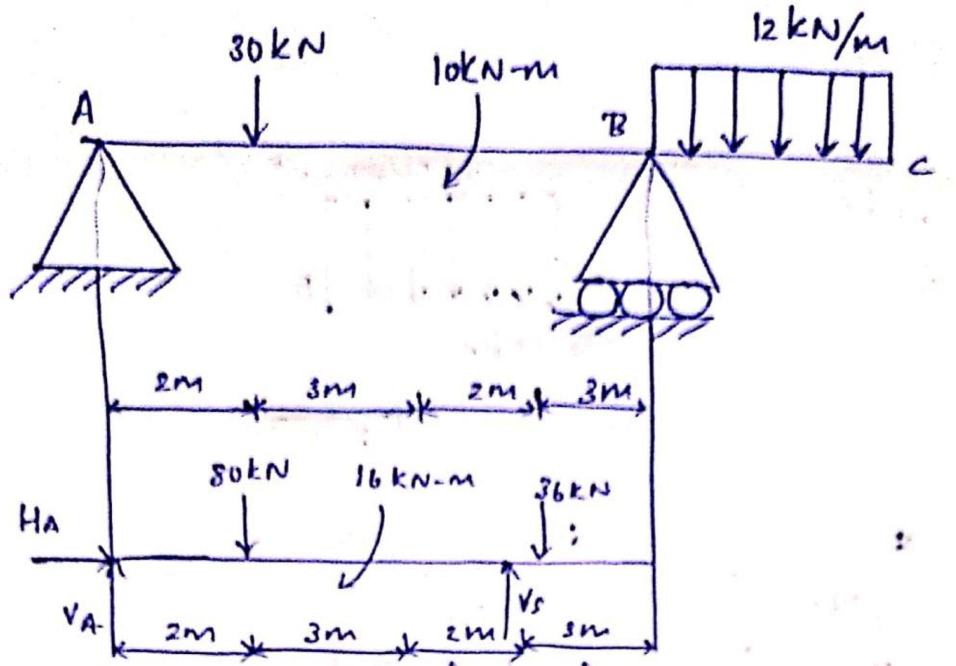
$V_B \times 4 = 4$

$\boxed{V_B = 1}$

$\boxed{V_A = 12}$ putting (1)

$$\boxed{\begin{aligned} V_A &= 12\,kN \\ V_B &= 1\,kN \\ H_A &= 0\,kN \end{aligned}}$$

4)



Converting UDL to point load

$P = 12 \times 3 = 36\ kN$

Applying condition of equillibrium.

$\Sigma F_x = 0$

$H_A = 0$

$\Sigma F_y = 0$

$V_A + V_B - 30 - 36 = 0$

$V_A + V_B = 66\ kN \longrightarrow (1)$

$\Sigma M_A = 0$

$30 \times 2 + 16 - V_B(7) + 36 \times (8.5) = 0$

$60 + 16 - 7V_B + 306 = 0$

$7V_B = 382$

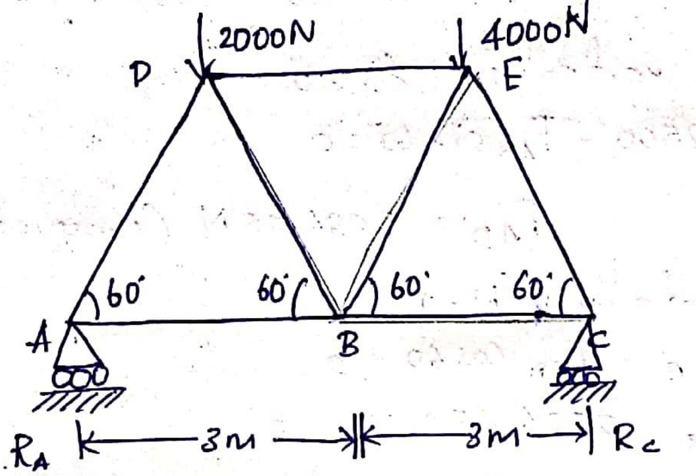
$\boxed{V_B = 54.571\ kN}$

$V_A = 66 - V_B$

$\boxed{V_A = 11.429\ kN}$

$V_A = 11.429\ kN$
$V_B = 54.571\ kN$
$H_A = 0$

5)



Soln Let R_A and R_C be the reactions at A and C respectively.

To find reactions:

Resolving Forces Vertically $\Sigma V = 0$

$$R_A + R_C = 2000 + 4000$$
$$= 6000N \quad \ldots (1)$$

Taking moment about A, $\Sigma M_A = 0$;

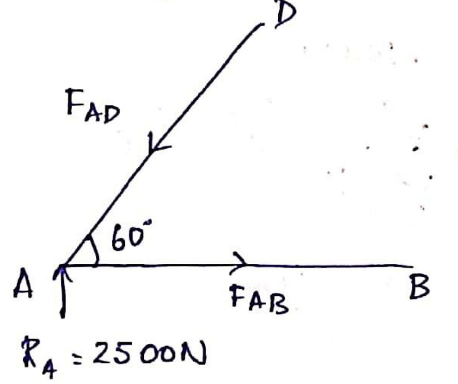
$$-R_C \times 6 + 2000 \times 1.5 + 4000 \times 4.5 = 0$$
$$R_C = 3500N \quad \ldots (2)$$

Substituting (2) in (1)

$$R_A + 3500 = 6000$$
$$R_A = 2500\,N \quad \ldots (3)$$

To find forces in the members of the truss:

Consider equillibrium of joint A:



Consider equillibrium of joint A. There are two unknown forces F_{AD} and F_{AB} in members AD and AB respectively. Assume suitable arrow directions at end A as shown in fig.

Resolving forces vertically : $\Sigma V = 0$

$$2500 - F_{AD} \sin 60 = 0$$

$$F_{AD} = 2886.75 N \text{ (compression)}$$

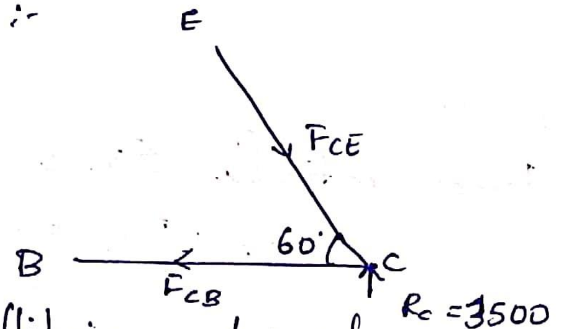
Resolving forces horizontally $\Sigma H = 0$

$$F_{AB} - F_{AD} \cos 60 = 0$$

$$F_{AB} - 2886.75 \cos 60 = 0$$

$$F_{AB} = 1443.38 N \text{ (Tension)}$$

Consider joint C :-



Consider equilibrium of joint C.

Resolving forces vertically $\Sigma V = 0$

$$3500 - F_{CE} \sin 60 = 0$$

$$F_{CE} = 4041.45 N \text{ (compression)}$$

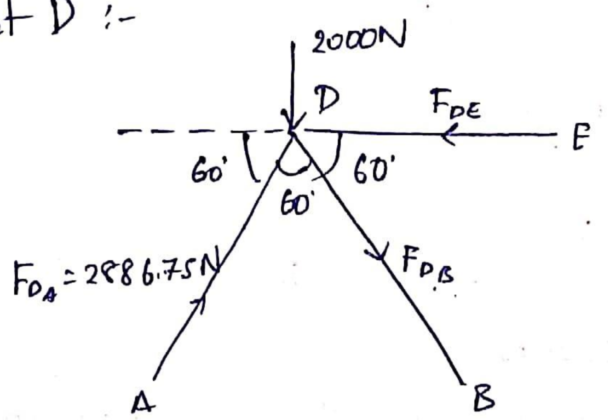
Resolving forces Horizontally : $\Sigma H = 0$

$$-F_{CB} + F_{CE} \cos 60 = 0$$

$$-F_{CB} + 4041.45 \cos 60 = 0$$

$$F_{CB} = 2020.73 N \text{ (Tension)}.$$

Consider Joint D :-



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Consider equillibrium of joint D.

Resolving forces Vertically, $\Sigma V = 0$

$$-2000 + 2886.75 \sin 60 - F_{DB} \sin 60 = 0$$

$$F_{DB} = 577.35 \text{N (Tension)}$$

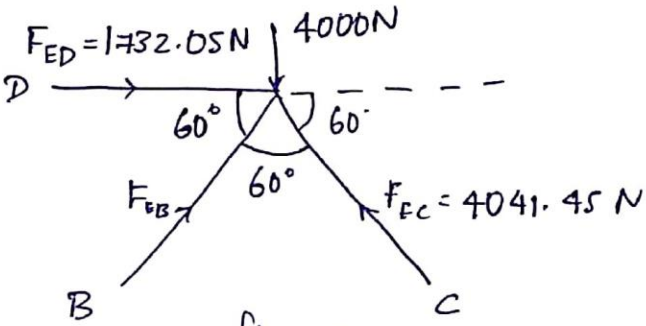
Resolving forces Horizontally $\Sigma H = 0$

$$2886.75 \cos 60 - F_{DE} + F_{DB} \cos 60 = 0$$

$$2886.75 \cos 60 - F_{DE} + 577.35 \cos 60 = 0$$

$$F_{DE} = 1732.05 \text{N (compression)}$$

Consider joint E :-



Resolving forces vertically $\Sigma V = 0$

$$-4000 + F_{EB} \sin 60 + 4041.45 \sin 60 = 0$$

$$F_{EB} = 577.35N$$

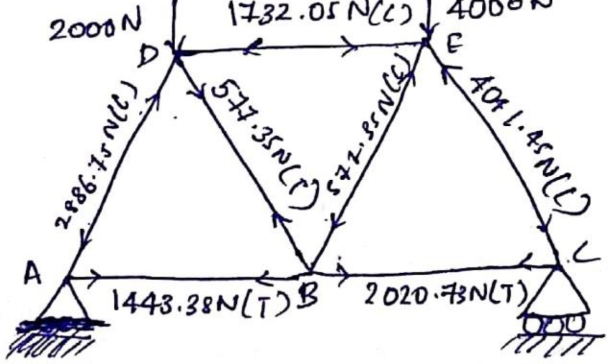
Resolving forces Horizontally, $\Sigma H = 0$

$$F_{EB} \cos 60 + F_{ED} - F_{EC} \cos 60 = 0$$

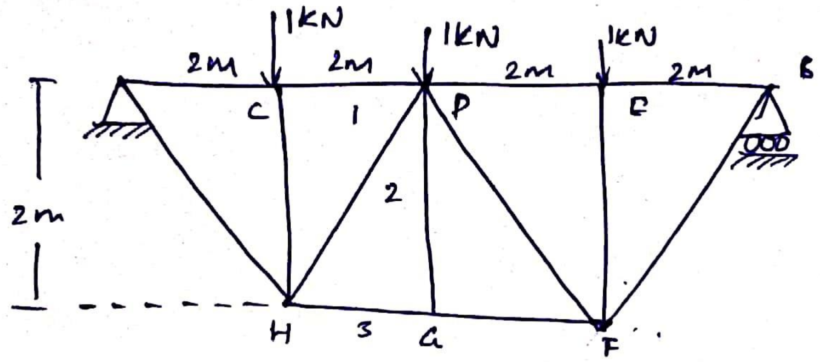
$$577.35 \cos 60 + 1732.05 - 4041.45 \cos 60 = 0$$

$$0 = 0 \text{ (check)}$$

The forces in all member are indicated in fig.



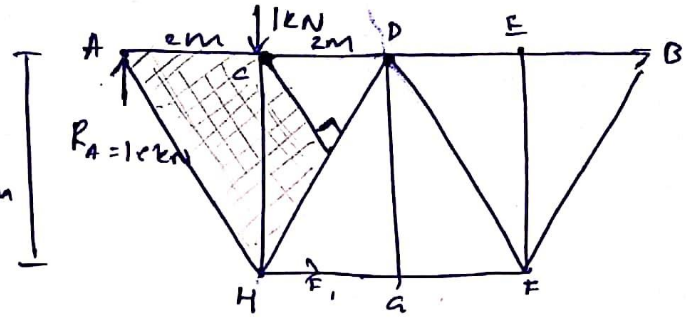
6)



To find reaction R_A and R_B

$$R_A = R_B = \frac{1}{2}(1+1+1) = 1.5kN$$

Force in moment (CD) :-



Taking moment about H of left portion.

$$\Sigma M_H = 0$$

$$-F_{CD} \times 2 + 1.5 \times 2 = 0$$

$$\boxed{F_{CD} = 1.5kN \text{ (Comp)}}$$

Force in member (GH) :-

Taking moment about D of left portion.

$$\Sigma M_D = 0$$

$$-F_{GH} \times 2 + 1.5 \times 4 - 1 \times 2 = 0$$

$$\boxed{F_{GH} = 2.0kN \text{ (Tensile)}}$$

Force in member (DH) :-

Taking moment about joint C

$$1.5 \times 2 - F_{DH} \times 2 + F_{DH}(2 \cos 45) = 0$$

$$1.5 \times 2 - 2 \times 2 + F_{DH}(2 \cos 45) = 0$$

$$\boxed{F_{DH} = 0.707kN \text{ (Comp)}}$$