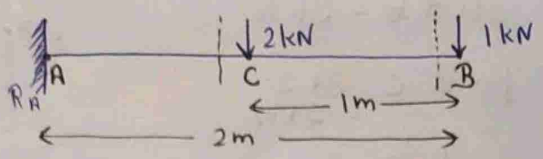
Shear force and Bending Moment

1- sol^n - Given data -



Step no.-1 Calculation of support reaction -

(i) $\Sigma F_y = 0$, (↑+ive, & ↓-ive)

$R_A - 2 - 1 = 0$ ⇒ $R_A = 3kN$

Step no.-2 S.F. calculation -

+ive ↑↓ -ive

(i) S.F. at point B ⇒ 1 kN

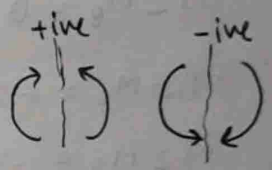
(ii) S.F. at point C ⇒ 3 kN

∵ no load b/w C & A.

∴ (iii) S.F. at point A ⇒ 3 kN

Step no.-3 B.M. calculation -

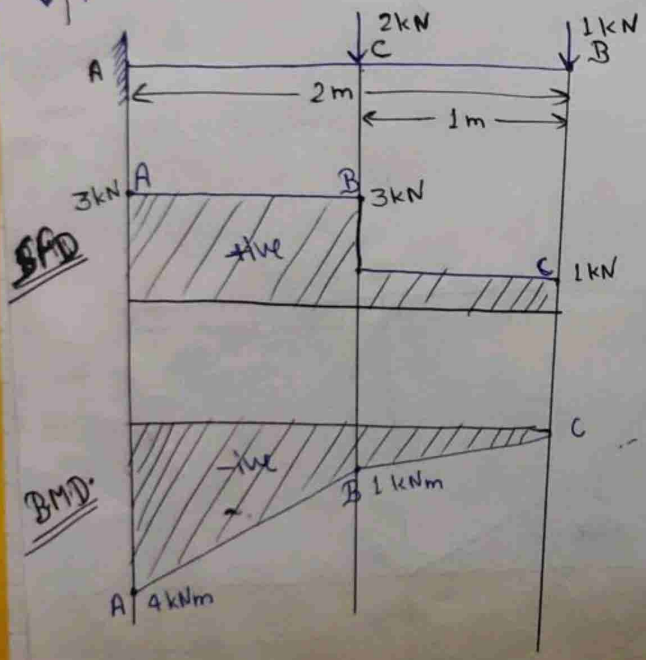
for cantilever beam B.M. at free end is zero.



(i) $\Sigma M_B = 0$

(ii) $\Sigma M_C = -1 \times 1$
$= -1\ kNm$

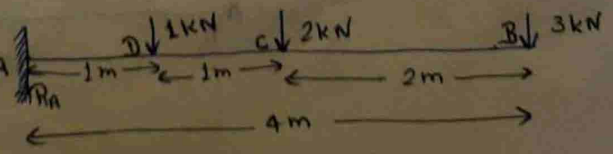
(iii) $\Sigma M_A = (-1 \times 2) + (-2 \times 1)$
$= -4\ kNm$



$\therefore (S.F.)_{max} = +3kN$

$(M)_{max} = -4\ kNm$ } zero.

2 - sol^n - Given data -



Step no-1 Calculation of support reaction -

(i) $\Sigma F_y = 0$, $R_A - 1 - 2 - 3 = 0$, $R_A = 6\ kN$

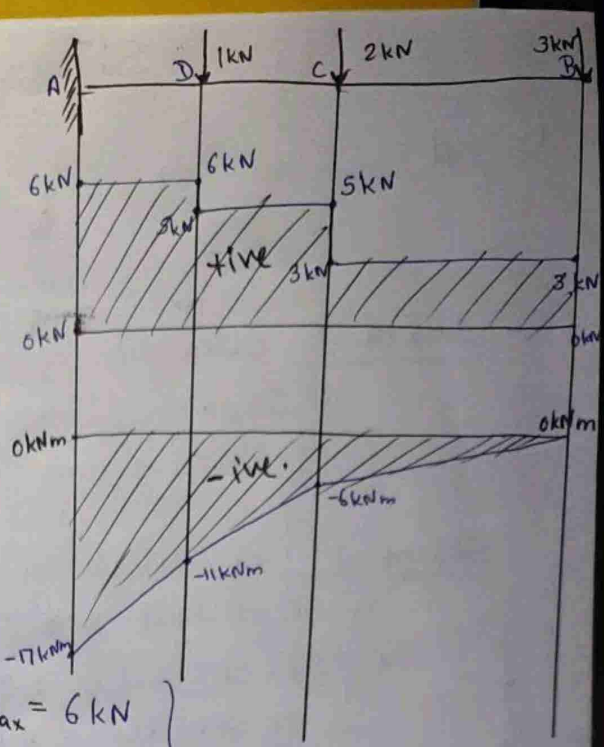
Step no.-2 = S.F. calculation -

(i) S.F. at point B - 3kN

(ii) S.F. at point C - 3+2 = 5kN

(iii) S.F. at point D - 1+2+3 ⇒ 6kN

(iv) S.F. at point A -
∵ no. load b/w C & A.
∴ $(S.F.)_A$ = 6kN



Step no. 3 ⇒ B.M. calculation -

(i) $\Sigma M_B = 0$

(ii) $\Sigma M_C = (-3 \times 2) = -6\ kNm$

(iii) $\Sigma M_D = (-3 \times 3) + (-2 \times 1)$
$= -11\ kNm$

(iv) $\Sigma M_A = (-3 \times 4) + (-2 \times 2) + (-1 \times 1)$
$= -17\ kNm$

10, - $(S.F.)_{max} = 6\ kN$
$M_{max} = -17\ kNm$

3- sol" - Taking section BC -
considering R.H.S of section x
Shear force = 0kN

For section AB-

$F_x = +(3\ kN/m \times x) = 3x\ kN$

∴ $F_B = 0$, $F_A = 3 \times 1 = 3\ kN$

Bending moment

If x is dist" from free end -

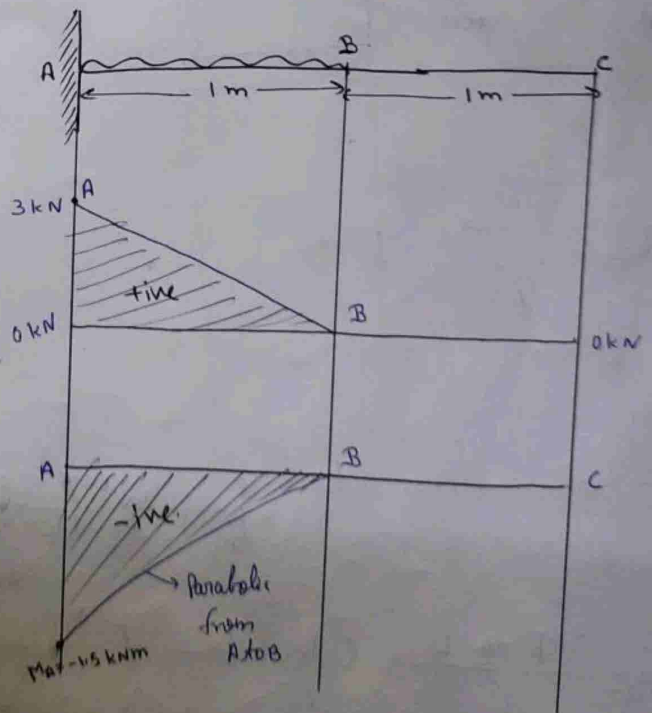
For section BC - $0 \le x \le 1$

$M_x = 0$,

For Section AB -

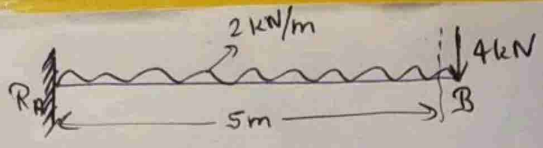
$M_x = -3x(x-1) \times \left(\frac{x-1}{2}\right)$

$M_B = 0$, $M_A = -1.5\ kNm$



10, $(S.F.)_{max} = 3\ kN$
$M_{max} = -1.5\ kNm$

4- sol^n - Given data -



Step no-1 Calculation of support reaction -

(i) $\Sigma F_y = 0$, $R_A - 2\times5 - 4 = 0$

$R_A = 14$ kN

Step no-2 S.F. calculation -

(i) S.F. at pt. B = 4 kN

(ii) S.F. at pt. A = $4 + 5\times2$

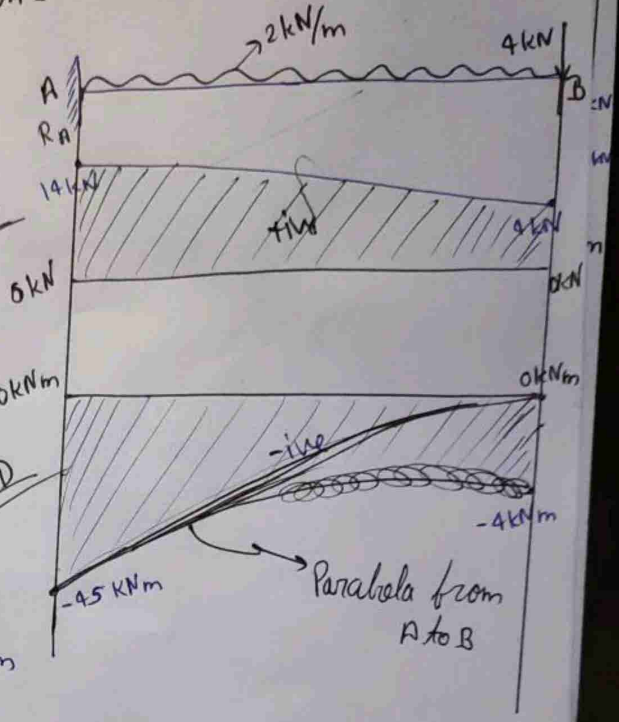
= 14 kN

Step no-3 B.M. calculation -

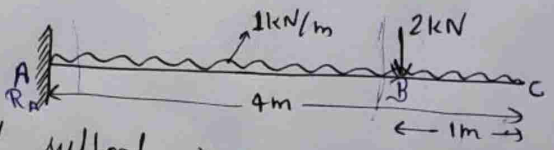
(i) B.M. at pt. B = 0 = 0 kNm

(ii) B.M. at pt. A = $(-4\times5) + \left(-5\times2\times\frac{5}{2}\right)$

= $-20 - 25 \Rightarrow -45$ kNm



5- sol^n - Given data -



Step no-1 Calculation of support r^n -

(i) $\Sigma F_y = 0$, $R_A - 2 - (1\times4) = 0$

$R_A \Rightarrow 6$ kN

Step no-2 S.F. calculation -

(i) (S.F.) at pt. C = 0 kN

(ii) S.F. at pt. B = (2+x) kN

= 3 kN

(iii) S.F. at pt. A = $2 + (1\times1) \Rightarrow 6$ kN

+ive -ive

(ii) S.F. at pt. B = 1 kN

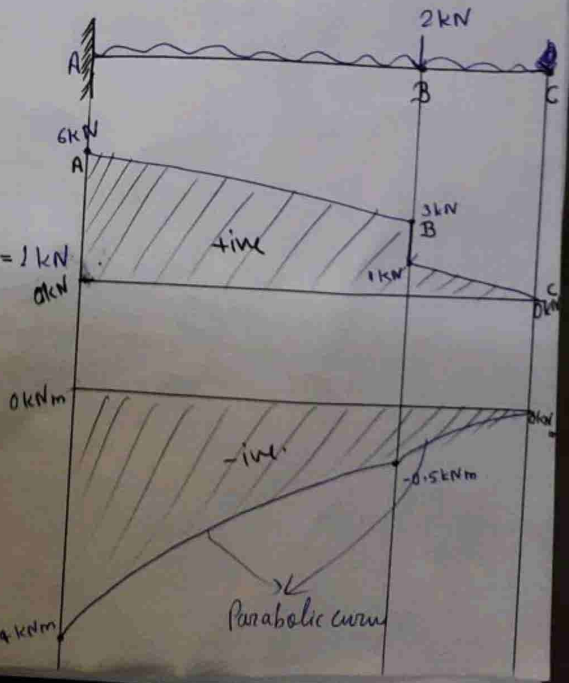
Step no-3 B.M. calculation -

(i) $(B.M.)_C = 0$

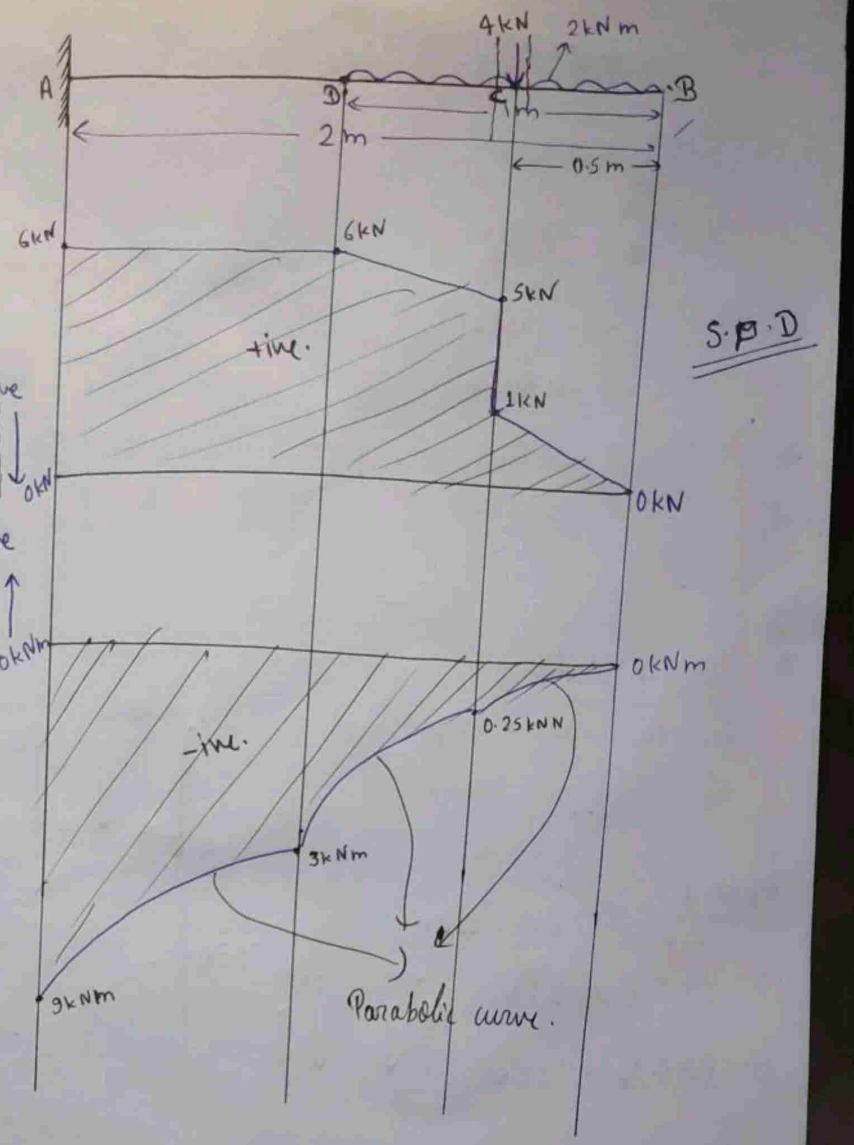
(ii) $(B.M.)_B = -1\times1\times\frac{1}{2} \Rightarrow -0.5$ kNm

(iii) $(B.M.)_A = (-2\times3) + \left(-1\times4\times\frac{4}{2}\right)$

= $-6 - 8 \Rightarrow -14$ kNm



6- sol^n - Given data -



Shear force - (S.F.) -

(i) S.F. at point B = 0 kN

(ii) S.F. at point C = $2 \times \frac{1}{2} = 1$ kN

(iii) S.F. at point C = $2 \times \frac{1}{2} + 4$
= 5 kN

(iv) S.F. at point D = $4 + 2 \times 1$
= 6 kN

(v) S.F. at point A = 6 kN
(∵ no load b/w A & D)

B.M

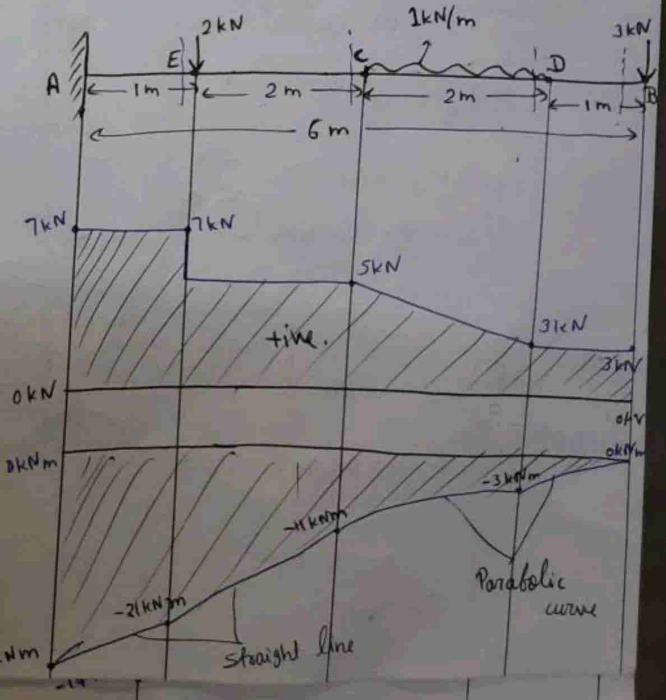
(i) M_B = 0 kNm (∵ it is free end)

(ii) $M_C = \left(2 \times \frac{1}{2} \times \frac{1}{4}\right)$ = 0.25 kNm

(iii) $M_D = \left(4 \times \frac{1}{2}\right) + \left(2 \times 1 \times \frac{1}{2}\right)$
= 3 kNm

(iv) $M_A = -\left(4 \times \frac{3}{2}\right) - \left(2 \times 1 \times \frac{3}{2}\right)$
⇒ -9 kNm

7- sol^n - Given data -



Shear force (S.F.) -

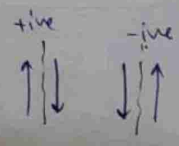
(i) S.F. at point B = 3kN

(ii) S.F. at point D = 3kN
(∵ no load b/w B & D)

(iii) S.F. at pt. C = 3 + (1 × 2) = 5kN

(iv) S.F. at pt. E = (5 + 2) = 7kN

(v) S.F. at pt. A = 7kN.
(∵ no load b/w E & A)



$(S.F.)_{max}$ = 7kN

$(B.M.)_{max}$ = -28kNm

Step-2

B.M. calculation-

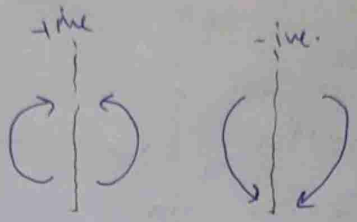
(i) $(B.M.)_B = 0\ kNm$

(ii) $(B.M.)_D = -3\ kNm$

(iii) $(B.M.)_C = (-3\times3)+(-1\times2\times1)$
$= -11\ kNm$

(iv) $(B.M.)_E = (-3\times5)+(-1\times2\times3)$
$= -21\ kNm$

(v) $(B.M.)_A = (-3\times6)+(-1\times2\times4)+(-2\times1)$
$= -18-8-2$
$= -28\ kNm$



8- Given data-

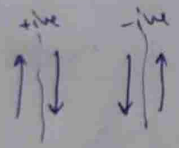
For UVL (uniform varying load)-

Point load $= \frac{1}{2}\times2\times6$
$= 6\ kN$

Step no-1 - S.F. calculation-

(i) $(S.F.)_B = 0\ kN$

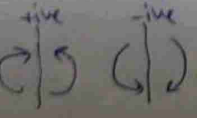
(ii) $(S.F.)_A = 6\ kN$



Step no-2 B.M. calculation-

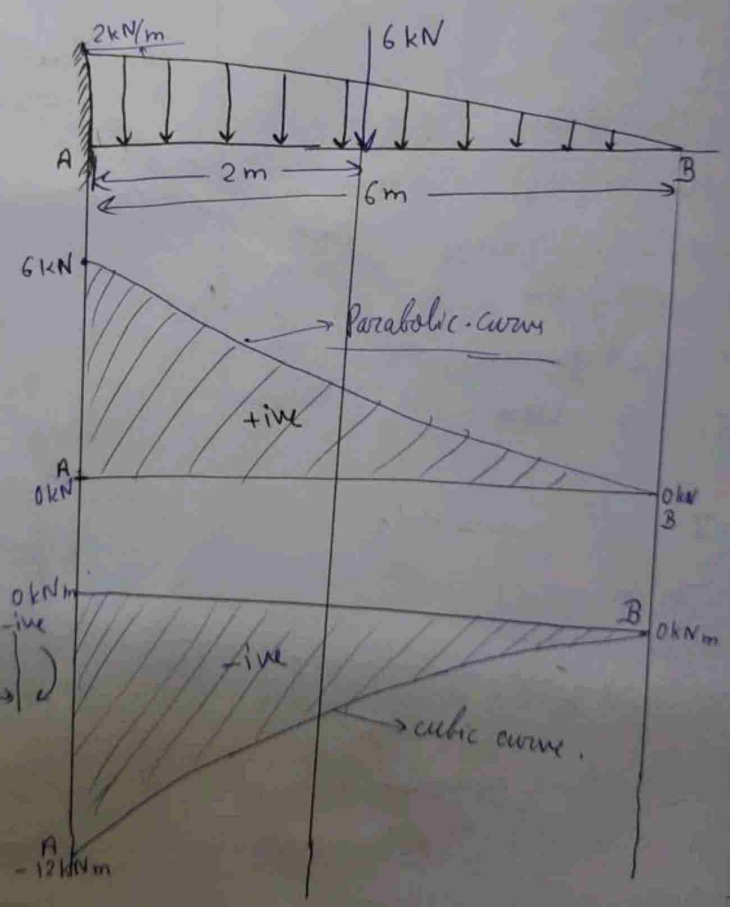
(i) $(B.M.)_B = 0$

(ii) $(B.M.)_A = -6\times2$
$= -12\ kNm$

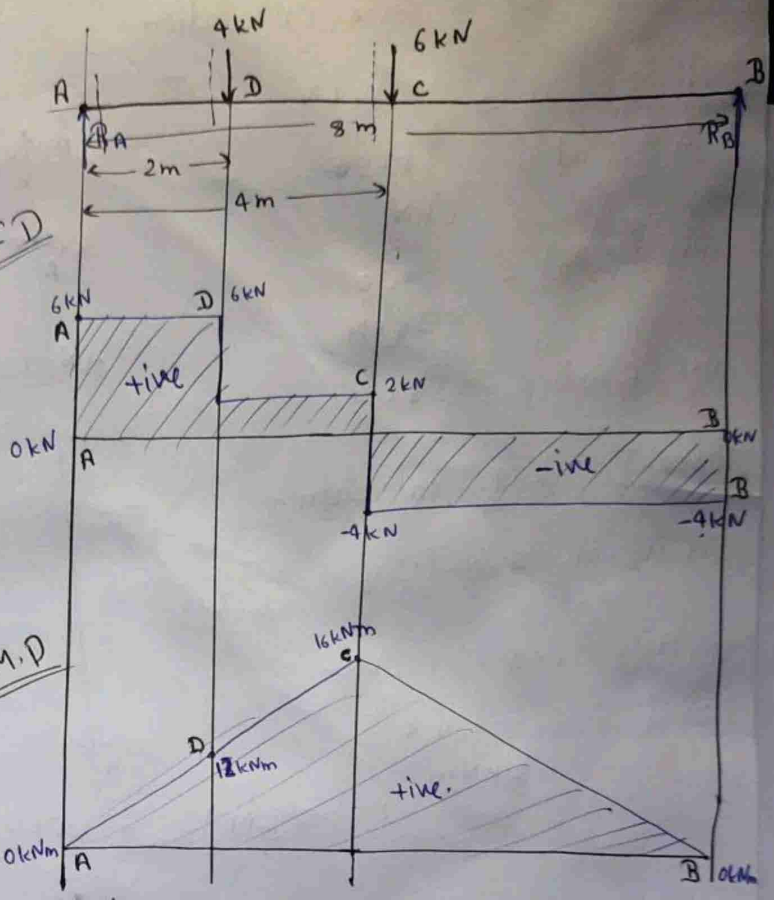


10. $(S.F.)_{max} = 6\ kN$

$M_{max} = -12\ kNm$



(9) Given data -



Step no-1 Calculation of support rx^n.

(i) $\Sigma F_y = 0$, (↑ive & ↓-ive)

$\therefore R_A + R_B = 10$ kN ——— (i)

(ii) $\Sigma M_A = 0$, (↻ ive & ↺ +ive)

$-4\times2 - 6\times4 + R_B\times8 = 0$

$8R_B = 32$

$R_B = 4$ kN

from eq^n (i)

$R_A = 6$ kN

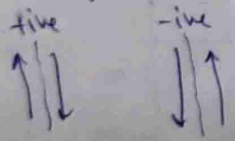
Step no-2 - Shear force calculation -

(i) S.F. at point B - -4 kN

(ii) S.F. at pt. C - (-4+6) = 2 kN

(iii) S.F. at pt. D - 2+4 = 6 kN

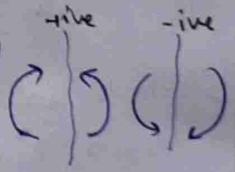
(iv) S.F. at pt. A → 6 kN



Step no-3 B.M. calculation -

(i) $M_A = M_B = 0$ kNm

(∵ it is simply supported)

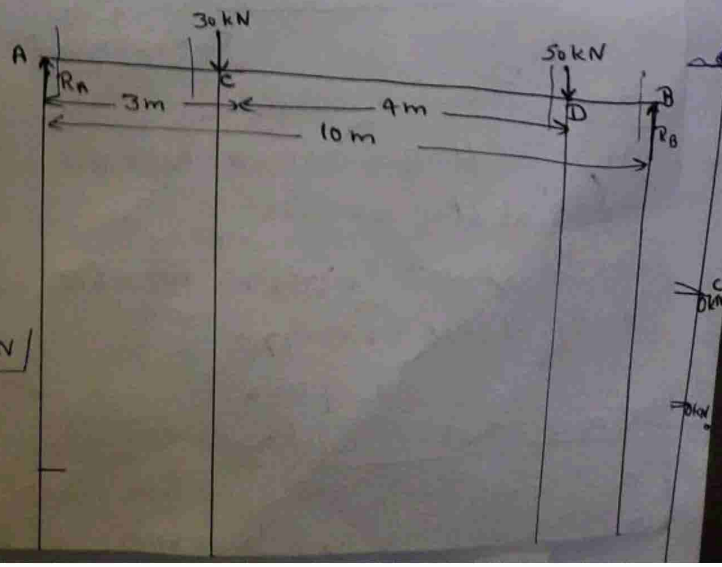


(ii) $M_C = 4\times4 = 16$ kNm

(iii) $M_D = (4\times6) - 6\times2 = 12$ kNm

(iv)

10 - Given data -



Step no-1 Calculation of support rx^n -

(i) $\Sigma F_y = 0$, $R_A + R_B = 80$ kN ——— (i)

(ii) $\Sigma M_A = 0$, (↻ ive & ↺ +ive)

$-30\times3 - 50\times7 + R_B\times10 = 0$

$R_B = 44$ kN from eq^n (i)

$R_A = 36$ kN

SFD

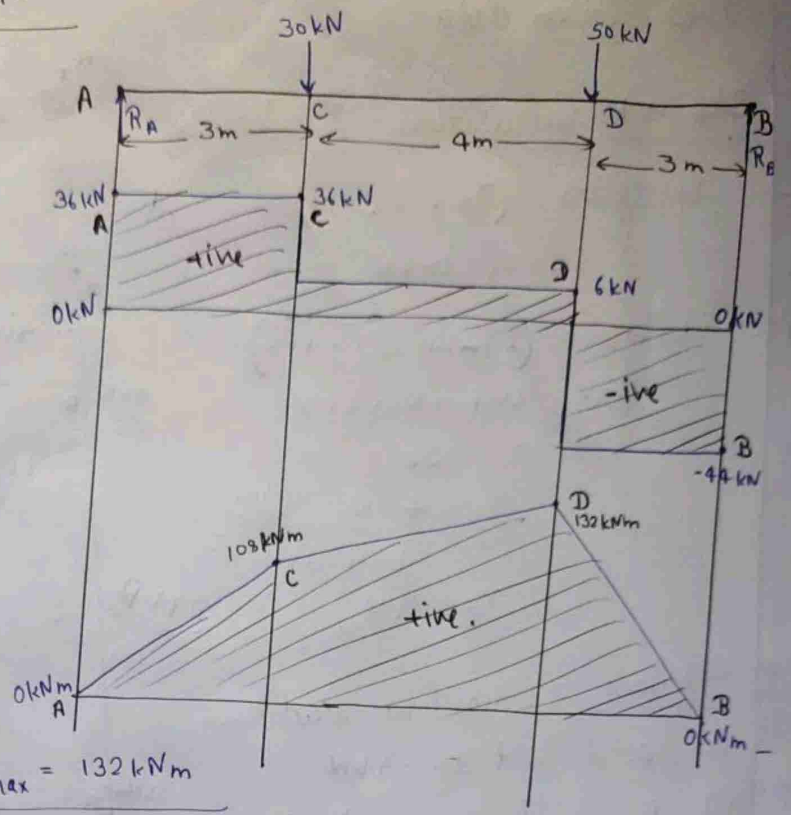
Step no-2 Shear force calculation -

(i) S.f. at B = -44 kN

(ii) S.f. at D = -44+50
= 6 kN

(iii) S.f. at C = 6+30
= 36 kN

(iv) S.f. at A = 36 kN.



Step no-3 - B.M. calculation -

(i) $M_A = M_B = 0$ kNm (∵ it is simply supported)

(ii) $M_D = 44 \times 3 = 132$ kNm

(iii) $M_C = 44 \times 7 - 50 \times 4$
= 108 kNm

10. $(B.M.)_{max} = 132$ kNm

11 - Given data -

Step no-1 Calculation of support rx -

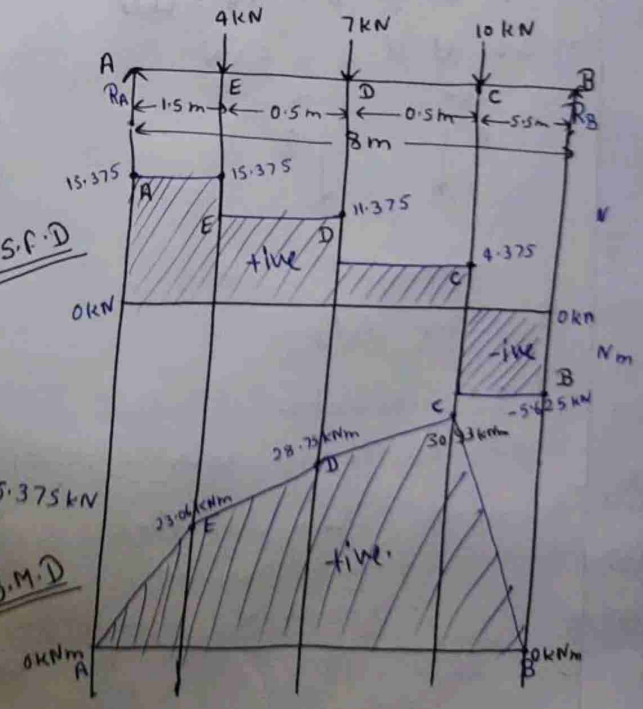
$\Sigma f_y = 0$, $R_A + R_B = 21$ kN ——— (i)

$\Sigma M_A = 0$, $\left(4 \times \frac{3}{2}\right) + (7 \times 2) + \left(10 \times \frac{5}{2}\right) = R_B \times 8$

$6 + 14 + 25 = R_B \times 8$

$R_B = 5.625$ kN (from eq (i))

$R_A = 15.375$ kN



S.f.D

B.M.D

Step no-2 Shear force calculation -

(i) S.f. at pt. B → -5.625 kN (ii) S.f. at pt. A = 15.375 kN

(ii) S.f. at pt. C → 10-5.625
= 4.375 kN

(iii) S.f. at pt. D → 4.375 + 7 = 11.375 kN

(iv) S.f. at pt. E → 4 + 11.375
= 15.375 kN

Step no-3 - B.M. calculation -

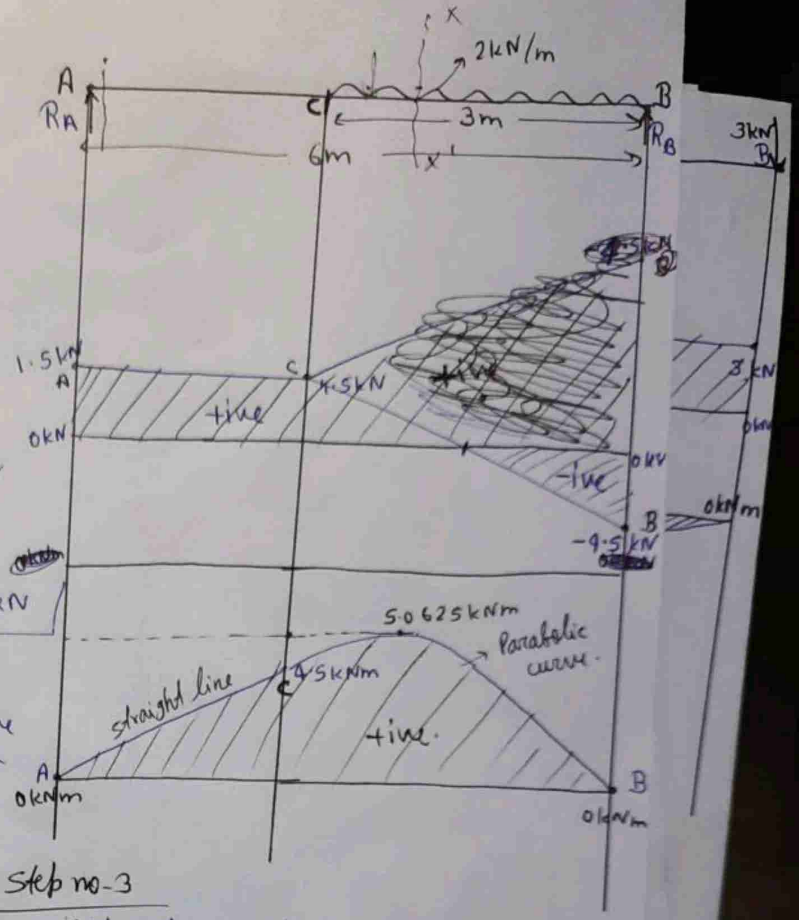
(i) $(B.M.)_A = (B.M.)_B = 0$ (∵ it is simply supported)

(ii) $(B.M.)_C = 5.625 \times 5.5 = 30.93$ kNm

(iii) B.M. at E = $(5.625 \times 6.5) - (10 \times 1) - (7 \times \frac{1}{2})$
= 23.06 kNm

(iv) B.M. at D = $(5.625 \times 5) - (10 \times \frac{1}{2})$ = 28.75 kNm

12 - Given data -



Step no-1 Calculation of support rx^n -

(i) $\Sigma F_y = 0$, (↑ +ive & ↓ -ive)

$\therefore R_A + R_B = 3 \times 2$

$= 6\ kN$ ——(i)

(ii) $\Sigma M_A = 0$,

$R_B \times 6 - \left(2 \times 3 \times \frac{3}{2}\right) = 0$

$R_B \times 6 = 27 \Rightarrow R_B = 4.5\ kN$

from eq^n (i)

$R_A = 1.5\ kN$

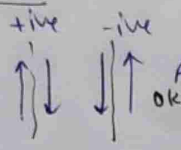
Step no-2 Shear force calculation -

(i) S.F. at point A = 1.5 kN

(ii) S.F. at point C = 1.5 kN

(iii) S.F. at pt. B = 1.5 + 2 × 3

= -4.5 kN.



for section CB -

$(B.M)_x = (1.5 \times x) + \left[2(x-3) \times \frac{x-3}{2}\right]$

$(B.M.)_x = 1.5x - (x-3)^2$

for max^m moment - $\frac{dM_x}{dx} = 0 \Rightarrow 1.5 - 2(x-3) = 0 \Rightarrow x = 3.75\ m$

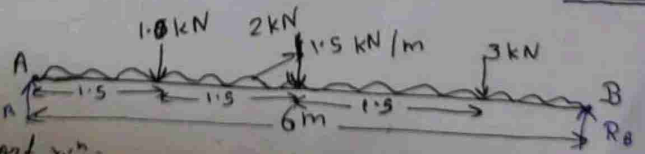
$\therefore$ Max. moment $= (1.5 \times 3.75) - (3.75-3)^2 \Rightarrow 5.0625\ kNm$

Step no-3

(i) $M_A = M_B = 0\ kNm$ (∵ it is simply supported)

(ii) $M_C = 1.5 \times 3 = 4.5\ kNm$

13 - Given data -



Step no-1 - Calculation of support rx^n.

(i) $\Sigma F_y = 0$ (↑ +ive & ↓ -ive)

$\therefore R_A + R_B = 6 + 1.5 \times 6$

$= 15\ kN$ ——(i)

(ii) $\Sigma M_A = 0$, $1 \times 1.5 + 2 \times 3 + 3 \times 4.5 + 9 \times 3 = R_B \times 6$

$6R_B = \frac{3+12+27+54}{2}$ $\Rightarrow 6R_B = \frac{96}{2}$ $\Rightarrow R_B = 8\ kN$

from eq^n (i)

$R_A = 7\ kN$

Step no-2-

(i) S.F. at point B = -8kN

(ii) S.F. at point C = -8+1.5×1.5
= -5.75kN

(iii) S.F. at point C = -8+1.5×1.5+3
= -2.75 kN

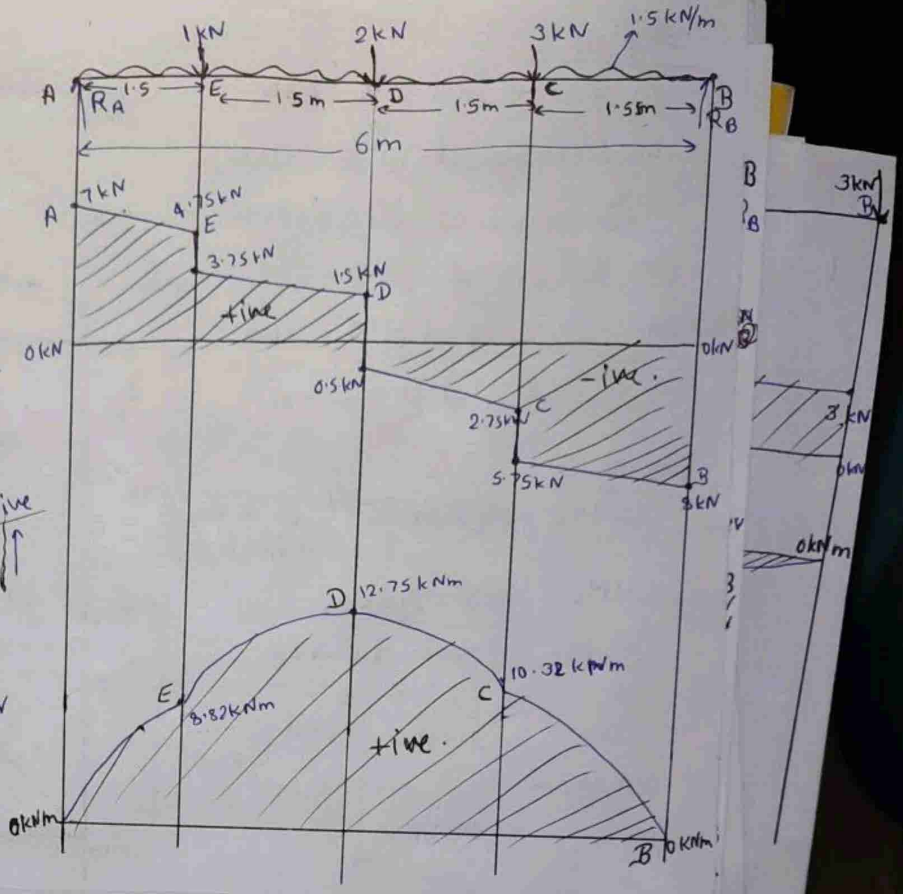
(iv) S.F. at point D = -2.75 + 2.25
= -0.5 kN

(v) S.F. at point D = (-0.5+2) kN
= 1.5 kN

(vi) S.F. at point E = 1.5 + (1.5×1.5)
= 3.75 kN

(vii) S.F. at point E = 3.75+1 = 4.75 kN

(viii) S.F. at point A = 4.75 + (1.5×1.5)
= 7kN



Step no-3 -

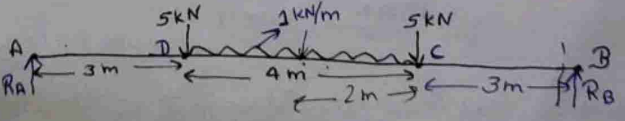
(i) $M_A = M_B = 0$ kNm
(∵ it is simply supported)

(ii) $M_C = (8\times1.5) - \left(1.5\times1.5\times\frac{1.5}{2}\right)$
= 10.32 kNm

(iii) $M_D = (8\times3) - (3\times\frac{3}{2}) - \left(1.5\times3\times\frac{3}{2}\right)$
= 24 - 4.5 × 6.75
= 12.75 kNm

(iv) $M_E = (8\times4.5) - (3\times3) - (2\times\frac{3}{2}) - \left(1.5\times4.5\times\frac{4.5}{2}\right)$
= 36 - 9 - 3 - 15.18
= 8.82 kNm

14- Sol^n Given data -



Step no-1 Calculation of support reaction -

$R_A + R_B = 10 + 1\times4 = 14$ kN ——— (i)

$\Sigma M_A = 0$, $R_B\times10 - 5\times7 - 5\times3 - 4\times5 = 0$

$10R_B = 70$

$R_B = 7$ kN

from eq^n (i)

$R_A = 7$kN

Step no-2

(i) S.F. at point B = -7 kN

(ii) Shear force at pt. C = -7kN

(iii) Shear force at pt. C = -2kN

(iv) Shear force at pt. D = 2kN

(v) Shear force at pt. D = 7kN

(vi) Shear force at pt. A = 7kN.

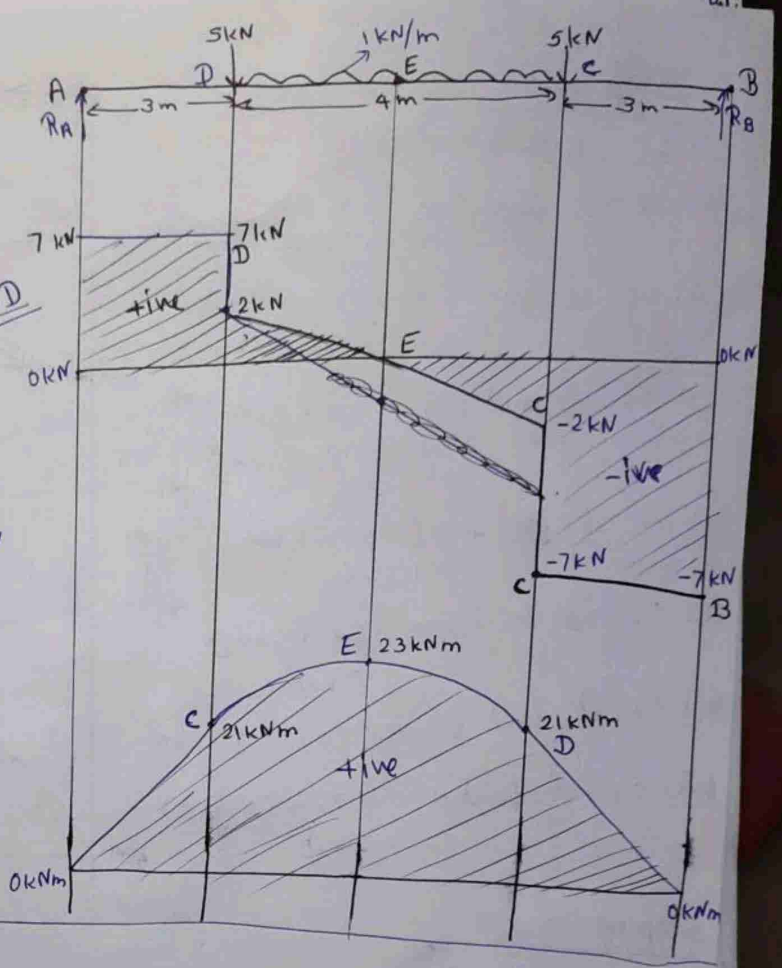
Step no-3-

(i) $M_A = M_B = 0 kNm$ (∵ it is simply supported)

(ii) $M_C = 7 \times 3 = 21 kNm$

(iii) $M_D = (7 \times 7) - 5 \times 4 - 4 \times 2$
$= 49 - 20 - 8$
$= 21 kNm$

(iv) $M_E = 7 \times 5 - (5 \times 2) - (\frac{1}{2} \times 2 \times 1)$
$= 23 kNm$

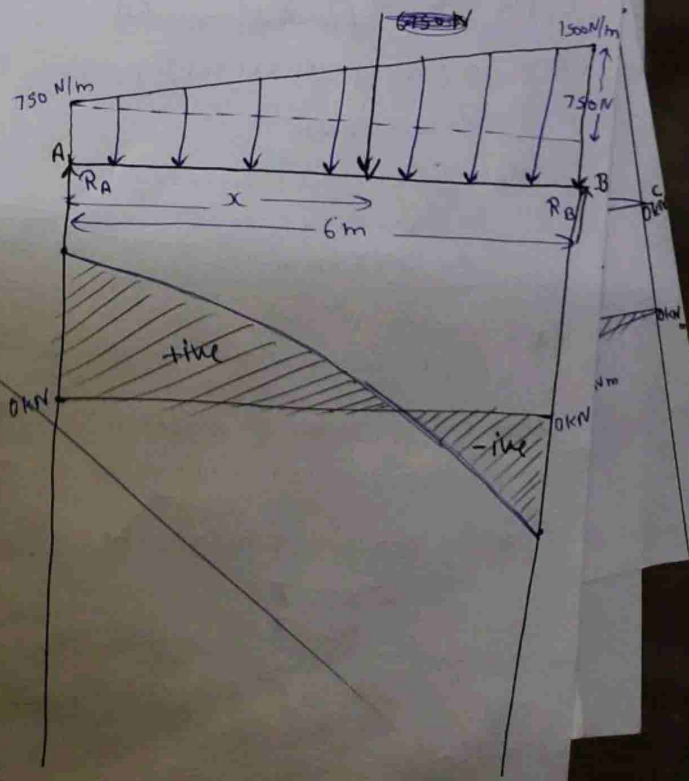


15 - Given data -

For UVL (Uniform varying load)

Point load = $\frac{1}{2}(750 + 1500) \times 6$

= 6750 N



Step no-1 $\Sigma F_y = 0$, $R_A + R_B = 6750 N$ ... (i)

$\Sigma M_A = 0$, $R_B \times 6 = (750 \times 6 \times 3) + (\frac{1}{2} \times 6 \times 750) \times \frac{2}{3} \times 6$

$R_B = 3750 N$ from eq^n (i)

$R_A = 3000 N$

Step no-2 Shear force calculation

(i) S.F. at point B ⇒ -3750 N

(ii) S.F. at point A ⇒ 3000 N

Step no-2 B.M. calculation.

(i) $M_A = M_B = 0$ (∵ it is simply supported)

(ii) $M_x = 3000x - (750 \times x \times \frac{x}{2}) - (\frac{1}{2} \times x \times (\frac{750}{6}) \times \frac{x}{3})$

$= 3000x - 375x^2 - (\frac{750}{2 \times 6 \times 3})x^3$

$\frac{dM_x}{dx} = 0 \Rightarrow 3000 - 750x - 62.5x^2 = 0$

$6R_B =$ 2

Problem 2 Shear f...

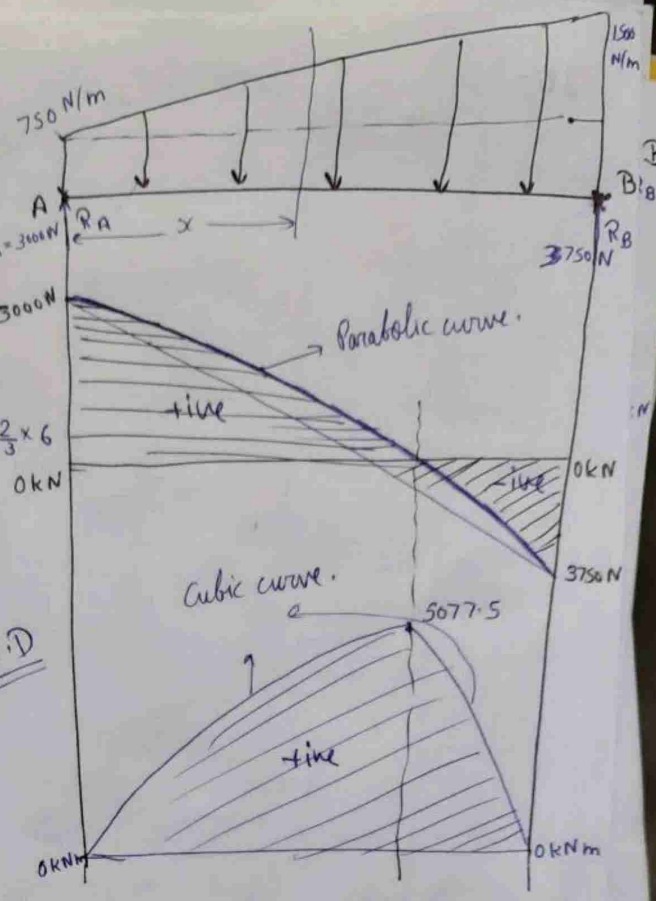
15- Given data -

for UVL (uniform varying load) -

~~Step no. 1~~

Point load = $\frac{1}{2}(750+1500)\times 6$

$= 6750\ N$



Step-1 $\Sigma F_y = 0$,

$R_A + R_B = 6750N$ S.F.D.

~~Step 2~~ $\Sigma M_A = 0$,

$R_B \times 6 = (750\times 6\times 3) + (\frac{1}{2}\times 6\times 750)\times\frac{2}{3}\times 6$

$R_B = 3750N$ / from eq^n (i)

$R_A = 3000N$ /

Step-2 - Shear force calculation -

(i) S.F. at point B = -3750N B.M.D

(ii) S.F. at point A = 3000 N

Step-3 B.M. calculation -

(i) $M_A = M_B = 0$ ($\because$ it is simply supported)

(ii) $M_x = 3000x - \left(750\times x\times\frac{x}{2}\right) - \left(\frac{1}{2}\times x\times\left(\frac{750}{6}\right)x\right)\times\frac{x}{3}$

$= 3000x - 375x^2 - \left(\frac{750}{2\times 6\times 3}\right)x^3$

for max^m B.M.

$\frac{dM_x}{dx} = 0$, $3000 - 750x - 62.5x^2 = 0$

after solving -

$x = 3.165$ m from left hand. /

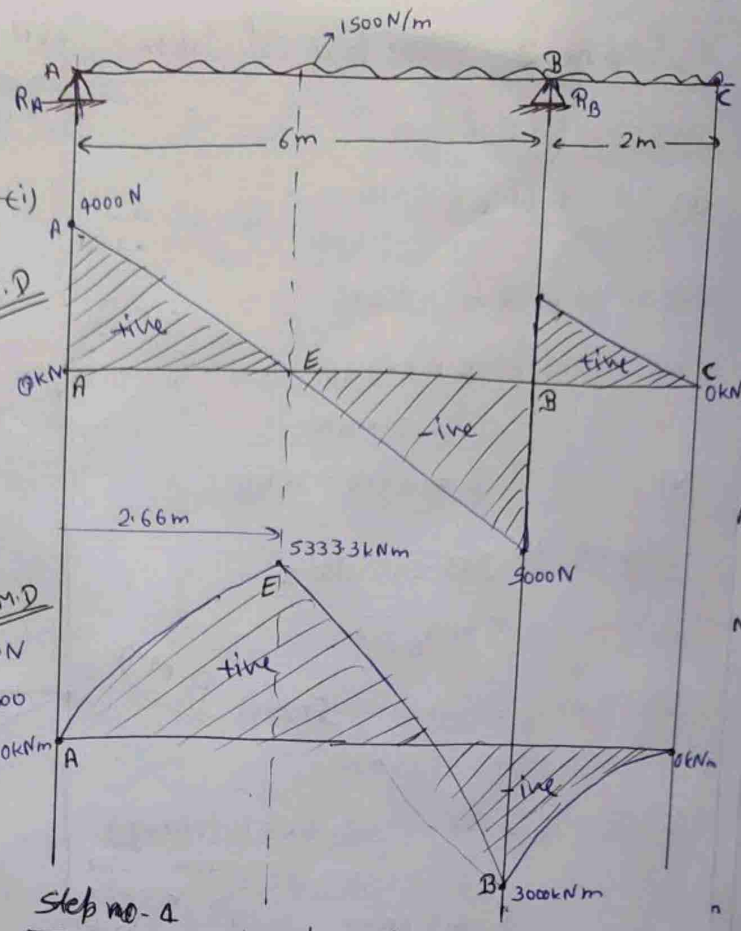
Max B.M. -

$3000(3.165) - 375(3.165)^2 - \frac{125}{6}(3.165)^3$

after solving -

$\Rightarrow 5077.5$ Nm /

16- Given data -



Step no-1 - $\Sigma F_y = 0$,

$R_A + R_B = 1500 \times 8$

$= 12,000\ N$ ——(i)

$\Sigma M_A = 0$, $R_B \times 6 = 12,000 \times 4$

$R_B = \frac{12000 \times 4}{6}$

$R_B = 8000\ N$

from eq (i)

$R_A = 4,000\ N$

Step no-2

(i) S.F. at point C = 0 kN

(ii) S.F. at point B = $1500 \times 2 = 3000\ N$

(iii) S.F. at point A = $(1500 \times 8) - 8000$

$= 4000\ N$

(iv) S.F at pt. B

$\rightarrow -8000 + 3000 \rightarrow -5000\ N$

Step no-3

(i) $(B.M.)_C = 0\ kNm$

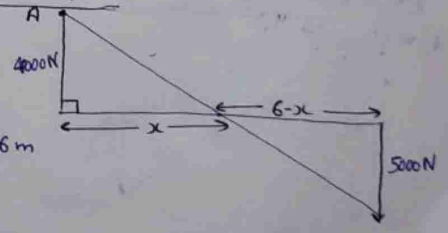
(ii) $(B.M.)_B = -1500 \times 2$

$= -3000\ kNm$

(iii) $(B.M.)_A = 0\ kNm$

Step no-4 Location of pt. of max. B.M -

By similarity of triangle -



$\frac{4000}{x} = \frac{5000}{6-x}$

$24 - 4x = 5x$

$x = 24/9 = 2.66\ m$

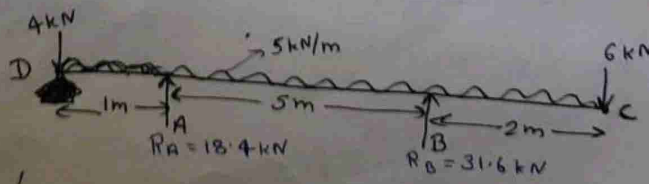
Step no-5 Calculation of Max. B.M. -

$(M_{max}) = (4000 \times 2.66) - \left(1500 \times 2.66 \times \frac{2.66}{2}\right)$

$= 10640 - 5306.7$

$(M)_{max} = 5333.3\ kNm$

17- Given data -



$R_A + R_B = 4 + 6 + (5 \times 8) = 50\ kN$

$\Sigma M_A = 0$, $R_B \times 5 = 6 \times 7 + \left(7 \times 5 \times \frac{7}{2}\right) - (4 \times 1) - 5/2$

$R_B = 31.6\ kN$, $R_A = 18.4\ kN$

Step no-2 Shear force calculation-

(i) S.F. at pt C = 6kN

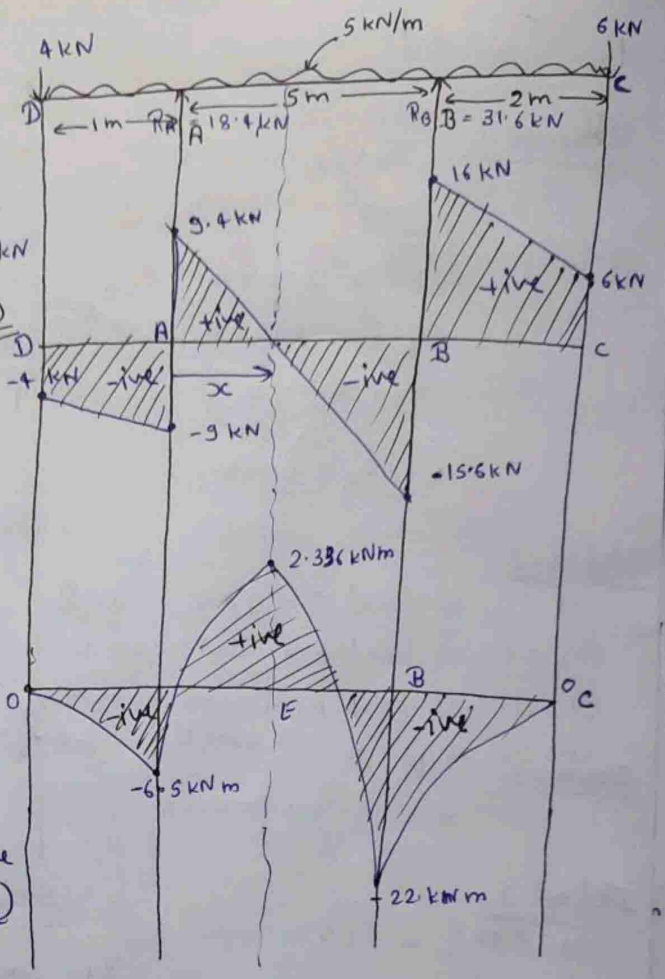
(ii) S.F. at pt. B = 6+10-31.6
= -15.6 kN

(iii) SF. at pt. A = -9 kN

(iv) S.F. at pt. A = 5×7+6-31.6
= 9.4 kN

(v) S.F. at pt. B = 6+10 = 16 kN

(vi) S.F. at D
= -4 kN



Step no-3 B.M. calculation-

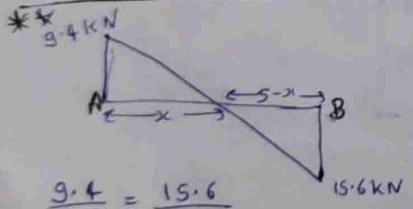
(i) $(B.M.)_C = (B.M.)_D = 0$

(ii) $(B.M.)_B = (-6\times2)+(-5\times2\times1)$
$= -22$ kNm

(iii) $(B.M.)_A = (-6\times7)+(31.6\times5)-(5\times7\times\frac{7}{2})$
$= -42+158-122.5$
$\Rightarrow -6.5$ kNm

+ive -ive

for point of contraflectia-



$\frac{9.4}{x} = \frac{15.6}{5-x}$

$47-9.4x = 15.6x$

$47 = 25x$

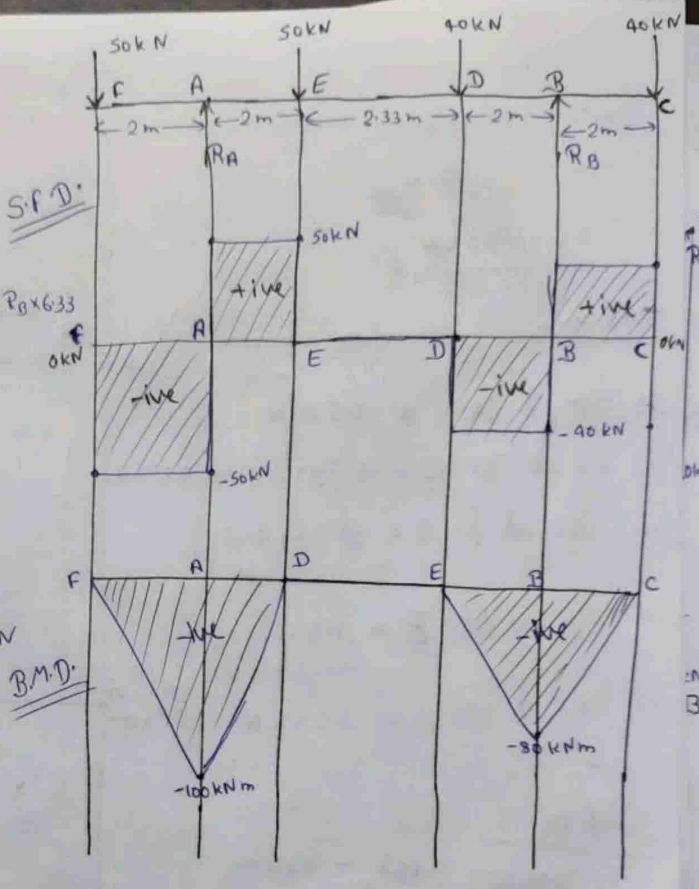
so, $x = 1.88$ m from left side.

** from right side
$\Rightarrow 2+5-x$
$\Rightarrow 7-1.88$
$\Rightarrow 5.119$ m

$M_E = (-4\times2.88)+(18.4\times1.88)-(5\times2.88\times\frac{2.88}{2})$
$= 2.336$ kNm

$\frac{dM}{dx}$

18- Given data –



Step no-1 Calculation of support rx^n-

(i) $\Sigma F_y = 0$,
$R_A + R_B = 180\,kN$ ——(i)

(ii) $\Sigma M_A = 0$,
$(50\times2) + (40\times4.33) + (40\times8.33) - 50\times2 = R_B \times 6.33$
after solving -
$R_B = 80\,kN$ from eq^n (i)
$R_A = 100\,kN$

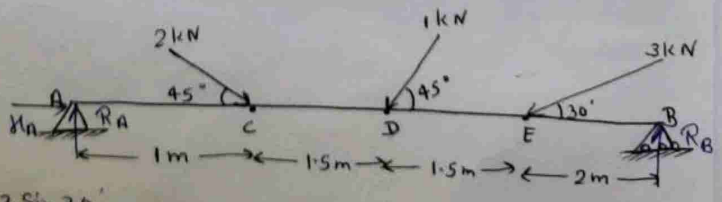
Step no-2 S.F. calculation -

(i) S.F. at point C = 40kN
(ii) S.F. at point B = (40-80) = -40kN
(iii) S.F. at point D = (40+40-80) = 0kN
(iv) S.F. at pt. E = 0+50 = 50kN
(v) S.F. at pt. A = 50-100 = -50kN
(vi) S.F. at pt. F = -50kN

Step no-3 B.M. calculation -

(i) $(B.M.)_C = 0\,kNm = (B.M.)_F$
(ii) $(B.M.)_B = (-40\times2) = -80\,kNm$
(iii) $(B.M.)_D = -40\times4 + 80\times2 = 0\,kNm$
(iv) $(B.M.)_E = (-40\times2.33) + (80\times4.33) - (40\times6.633) = 0\,kNm$
(v) $(B.M.)_A = (-40\times8.33) + (80\times6.33) - (40\times4.33) + 50\times2$
$= 100\,kNm$
(vi) $(S.F.)_{max} = 50\,kN$
$(B.M.)_{max} = 100\,kNm$

19- Given data -



Step no-1 Calculation of support rx^n-

$\Sigma F_y = 0$,
$R_A + R_B = 2\sin45° + 1\sin45° + 3\sin30°$
$= 2/\sqrt{2} + 1/\sqrt{2} + 3/2$
$= 2.12 + 1.5$
$\therefore R_A + R_B = 3.62\,kN$ ——(i)

$\Sigma M_A = 0$,
$(2\sin45°\times1) + (1\sin45°\times2.5) + (3\sin30°\times4) = R_B \times 6$
$\frac{2}{\sqrt{2}} + \frac{2.5}{\sqrt{2}} + \frac{12}{2} = R_B \times 6$
after solving -
$R_B = 1.53\,kN$

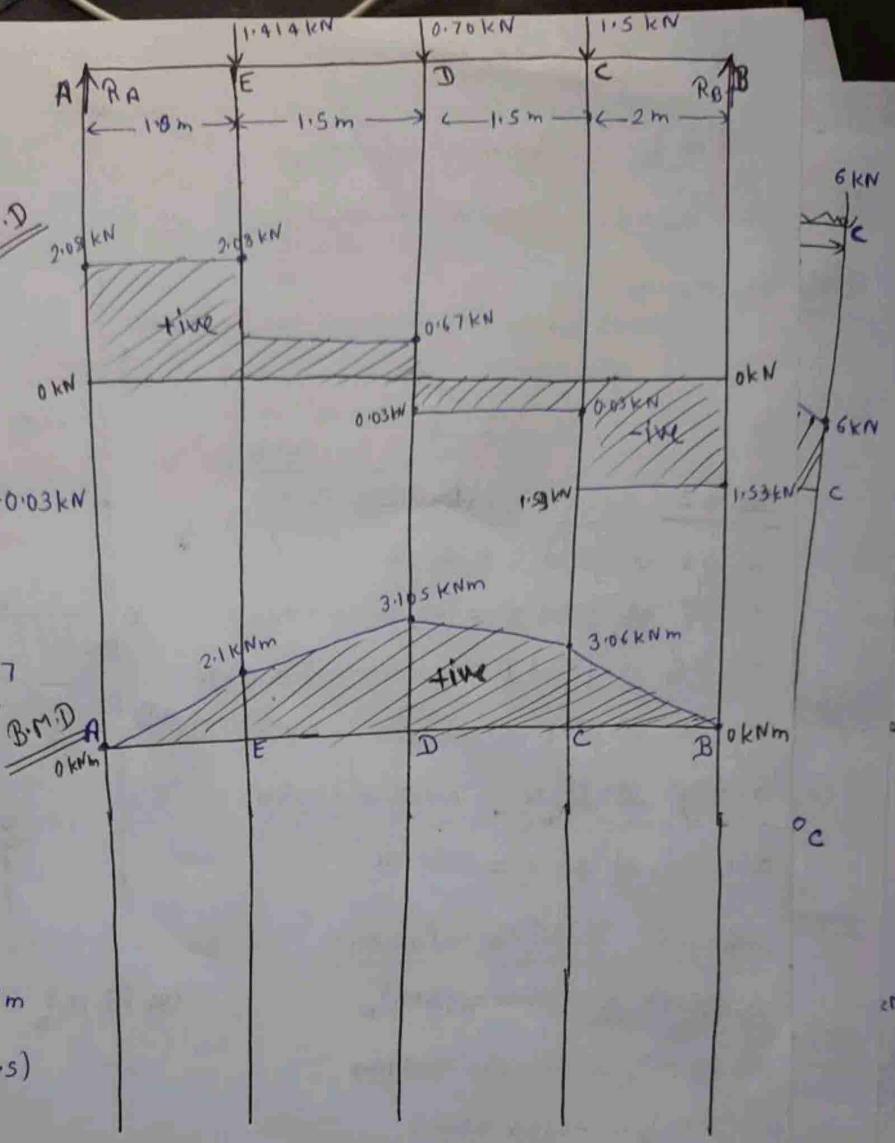
from eq^n (i)
$R_A = 2.09\,kN$

$\Sigma F_x = 0,$

$H_A + 2\cos 45' - 1\cos 45' - 3\cos 30' = 0$

$H_A = \frac{3+\sqrt{3}}{2} + \frac{1}{\sqrt{2}} - \frac{2}{\sqrt{2}}$

$H_A = 1.88\ kN$



Step no-2 S.F. calculation -

(i) S.F. at pt. B = -1.53 kN

(ii) S.F at pt. C = 1.5 - 1.53 = -0.03 kN

(iii) S.F. at pt. D = -0.03 + 0.7
= 0.67 kN

(iv) S.F. at pt. E = 1.414 + 0.67
= 2.08 kN

(v) S.F. at pt. A = 2.08 kN

Step no-3

(i) $(B.M.)_B = (B.M.)_A = 0\ kNm$

(ii) $(B.M.)_C = (1.53 \times 2) = 3.06\ kNm$

(iii) $(B.M.)_D = (1.53 \times 3.5) - (1.5 \times 1.5)$
$= 3.105\ kNm$

(iv) $(B.M.)_E = (1.53 \times 5) - (1.5 \times 3) - (0.7 \times 1.5)$
$= 7.65 - 4.5 - 1.05$
$= 2.1\ kNm$

$\frac{dM_x}{dx}$

~~20~~- Given data -

20- Taking $\Sigma M_A = 0$,

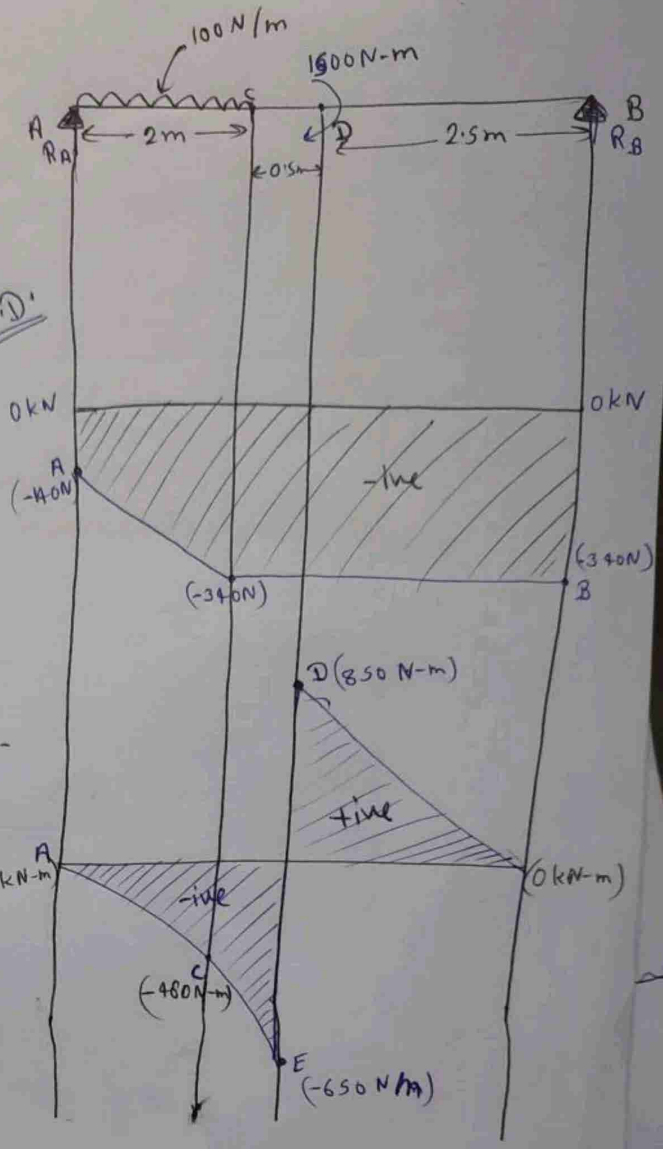
M_A due to UDL = $100 \times 2 \times 1$

= 200 N-m clockwise.

$R_B \times 5 = 1700$

$R_B = 340$ N

S.F.D'



Step-2 Shear force calculation -

(i) S.F. at point B = -340 N

(ii) S.F. at point C = -340 N

(iii) S.F. at point A = -340 + 200

= -140 N.

Step-3 Bending Moment calculation -

(i) (B.M.) at pt. B = 0 N-m

(ii) (B.M.) at pt. D = 340(2.5)

= 850 N-m

(iii) (B.M.) at pt. D = 850 - 1500

= -650 N-m

(iv) $(B.M.)_C$ = (340×3) - 1500

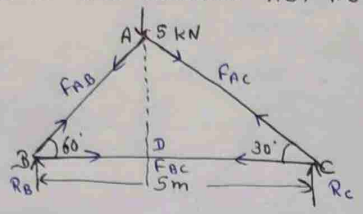
= -480 N-m

(v) $(B.M.)_A$ = 0 N-m

∴ max^m B.M = 850 N-m

Analysis of perfect frame -

1- Find the forces in the members AB, AC and BC of the truss.



Sol^n - First determine R_B & R_C

$\Sigma F_y = 0$, $R_B + R_C = 5$ kN ——— (i)

$\Sigma M_B = 0$,

$R_C \times 5 - 5 \times 1.25 = 0$

$R_C = \frac{5 \times 1.25}{5}$, $R_C = 1.25$ kN

from eq^n (i) -

$R_B = 3.75$ kN

$\because$ $\triangle ABC$ is right angle triangle.

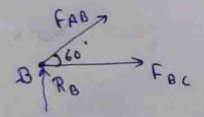
$\therefore$ $AB = BC \cos 60°$

$= 5 \cos 60°$

$BD = (5 \cos 60°) \cos 60°$

$= 5/4 = 1.25$ m

Joint B -



$\Sigma F_y = 0$,

$R_B + F_{AB} \sin 60° = 0$

$F_{AB} = -\frac{3.75}{\sin 60°} = -\left(\frac{3.75 \times 2}{\sqrt{3}}\right)$

$F_{AB} = -4.33$ kN

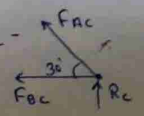
$\Sigma F_x = 0$, $F_{BC} + F_{AB} \cos 60° = 0$

$F_{BC} = -F_{AB} \cos 60°$

$\Rightarrow$, $F_{BC} = +4.33 \times \frac{1}{2}$

$F_{BC} = +2.165$ kN

Joint C -



$\Sigma F_y = 0$

$R_C + F_{AC} \sin 30° = 0$

$F_{AC} = -\left(\frac{R_C}{\sin 30°}\right)$

$= -(1.25 \times 2)$

$F_{AC} = -2.5$ kN

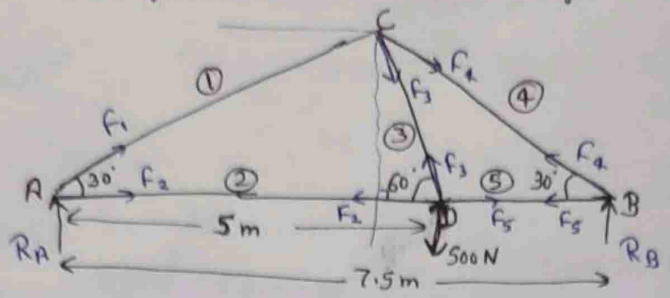
$\Rightarrow$, AB = 4.33 kN (comp.)

AC = 2.5 kN (comp.)

BC = 2.165 kN (Tens.)

Q-

2- A truss of span 7.5 m carries a point load 500 N at D. Find the reaction and forces in the members of the truss.



sol" First determine R_A & R_B -

$\Sigma F_y = 0$, $R_A + R_B = 500\ N$ ——— (i)

$\Sigma M_A = 0$,

$R_B \times 7.5 - 500 \times 5 = 0$

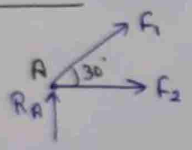
$\therefore R_B = \frac{2500}{7.5} = 333.33\ N$,

from eq" (i)

$R_A = 500 - 333.33$

$R_A = 166.67\ N$

Joint A



$\Sigma F_y = 0$, $R_A + F_1 \sin 30° = 0$

$F_1 = \frac{-R_A}{\sin 30°} = -\frac{166.67 \times 2}{}$

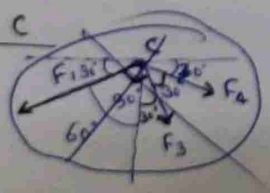
$F_1 = -333.34\ N$

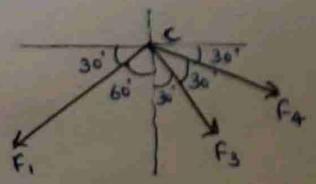
$\Sigma F_x = 0$, $F_1 \cos 30° + F_2 = 0$

$\therefore F_2 = -F_1 \cos 30°$

$= -(-333.34) \cdot \cos 30° \Rightarrow 288.67\ N = F_2$

Joint C





$\Sigma F_y = 0$,

$-F_1 \sin 30° + F_3 \cos 30° - F_4 \cos 60° = 0$

$F_3 \cos 30° + F_4 \cos 60° = -(-333.34 \times \frac{1}{2})$

$\sqrt{3} F_3 + F_4 = 333.34$ ——— (ii)

$\Sigma F_x = 0$,

$-F_1 \cos 30° + F_4 \sin 60° + F_3 \sin 30° = 0$

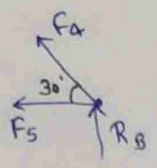
$-\sqrt{3} F_1 + \sqrt{3} F_4 + F_3 = 0$

$F_3 + \sqrt{3} F_4 = -577.34$ ——— (iii)

after solving eq" (ii) & (iii) -

$F_3 = 577.35\ N$ $F_4 = -666.66\ N$

Joint B -



$\Sigma F_x = 0$,

$-F_5 - F_4 \cos 30^\circ = 0$

$F_5 = -F_4 \cos 30^\circ \Rightarrow -(-666.66) \times \frac{\sqrt{3}}{2}$

$F_5 = 577.32\ N$

$\therefore R_A = 166.67\ N$

$R_B = 333.33 N$

$F_1 = 333.34\ N$ (comp.)

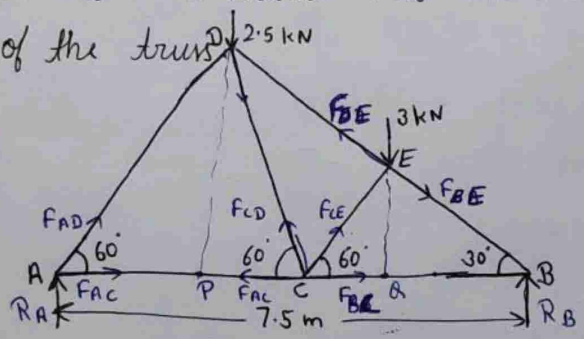
$F_2 = 288.67\ N$ (Tens.)

$F_3 = 577.35\ N$ (Tens.)

$F_4 = 666.66\ N$ (comp.)

$F_5 = 577.32\ N$ (Tens.)

3- A truss of span 7.5 m is loaded. Find the reactions and forces in the members of the truss



sol^n - First determine R_A & R_B -

$\Sigma F_y = 0$, $R_A + R_B = 5.5\ kN$ ——— (i)

$\Sigma M_A = 0$,

$(R_B \times 7.5) - (2.5 \times 1.875) - (3 \times 4.68) = 0$

$(7.5) R_B = 18.7275$

$\therefore R_B = \frac{18.7275}{7.5}$, $R_B = 2.5\ kN$

from eq^n (i)

$R_A = 3\ kN$

$\because \Delta ADB$ is right angle Δ.

$AD = 7.5 \cos 60^\circ$

$= 3.75$

$\therefore AP = 3.75 \cos 60^\circ$

$= 1.875$

$\because \Delta ACD$ is equilateral Δ.

$AC = AD = CD = 7.5 \cos 60^\circ$

ΔCED is right angle Δ.

$CE = (7.5 \cos 60^\circ) \times \cos 60^\circ$

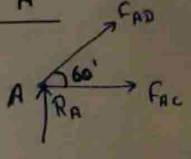
$\therefore CQ = [(7.5 \cos 60^\circ) \times \cos 60^\circ] \cos 60^\circ$

$= 0.93$

$AQ = AC + CQ$

$= \frac{7.5}{2} + 0.93$, $(AQ = 4.68)$

Joint A



$\Sigma F_y = 0$,

$R_A + F_{AD} \sin 60^\circ = 0$

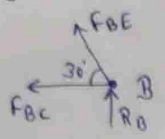
$F_{AD} = -\left(\frac{3 \times 2}{\sqrt{3}}\right)$

$F_{AD} = -3.464\ KN$

$\Sigma F_x = 0$

$F_{AC} + F_{AD} \cos 60^\circ = 0$, $\therefore F_{AC} = 1.732\ kN$

Joint B -



$\Sigma F_x = 0$,

$-F_{BC} - F_{BE}\cos 30° = 0$

$F_{BC} = -F_{BE}\cos 30°$

$F_{BC} = -(-5)\times\frac{\sqrt{3}}{2}$

$F_{BC} = 4.33$ kN

$\Sigma F_y = 0$,

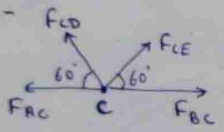
$R_B + F_{BE}\sin 30° = 0$

$F_{BE} = -\left(\frac{R_B}{\sin 30°}\right)$

$F_{BE} = -(2.5\times 2)$

$F_{BE} = -5$ kN

Joint C -



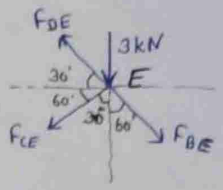
$\Sigma F_y = 0$,

$F_{CD}\sin 60° + F_{CE}\sin 60° = 0$

$F_{CD} = \frac{2.598\sin 60°}{\sin 60°}$

10, $F_{CD} = 2.598$ kN

Joint E -



$\Sigma F_x = 0$,

$-F_{CE}\cos 60 - F_{DE}\cos 30 + F_{BE}\cos 30$

Resolving force along BED line -

$F_{DE} = F_{BE} + 3\cos 60°$

$= -5 + 1.5$

$F_{DE} = -3.5$ kN

Resolving force along EC -

$F_{CE} + 3\sin 60° = 0$

$F_{CE} = -\frac{3\times\sqrt{3}}{2} = -2.598$ kN

10, AD = 3.464 kN (Comp.)

AC = 1.732 kN (Tens.)

CD = 2.598 kN (Tens.)

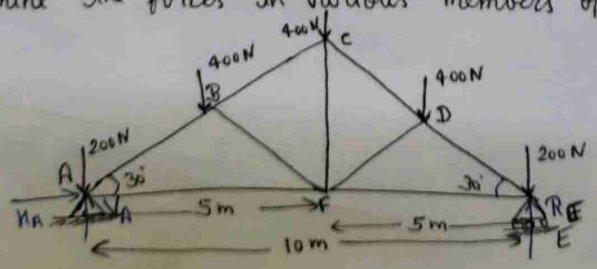
CE = 2.598 kN (Comp.)

DE = 3.50 kN (Comp.)

BE = 5 kN (Comp.)

BC = 4.33 kN (Tens.)

4 - Determine the forces in various members of the truss -



Sol^n - $\Sigma F_x = 0$, $H_A = 0$

$\Sigma F_y = 0$, $V_A + R_E = 1600$ N ——(i)

$\Sigma M_A = 0$

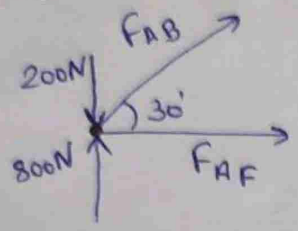
$\left(400\times\frac{5}{2}\right) + (400\times 5) + \left(400\times\frac{15}{2}\right) + (200\times 100) = R_E\times 10$

$100 + 200 + 300 + 200 = R_E$

10, $R_E = 800$ N from eq^n(i) - $V_A = 800$ N

~~4- Determine the forces~~

Joint A -



$\Sigma F_y = 0,$

$-200 + 800 + F_{AB} \sin 30^\circ = 0$

$F_{AB} \times \frac{1}{2} = 600$

$F_{AB} = 1200\,N$

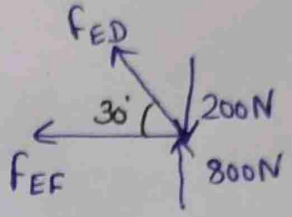
$\Sigma F_x = 0,$

$F_{AF} + F_{AB} \cos 30^\circ = 0$

$F_{AF} = -1200 \times \frac{\sqrt{3}}{2}$

$F_{AF} = -(1039.23)\,N$

Joint E -



$\Sigma F_y = 0,$

$-200 + 800 + F_{ED} \sin 30^\circ = 0$

$F_{ED}\left(\frac{1}{2}\right) = -600$

$F_{ED} = -1200\,N$

$\Sigma F_x = 0,$

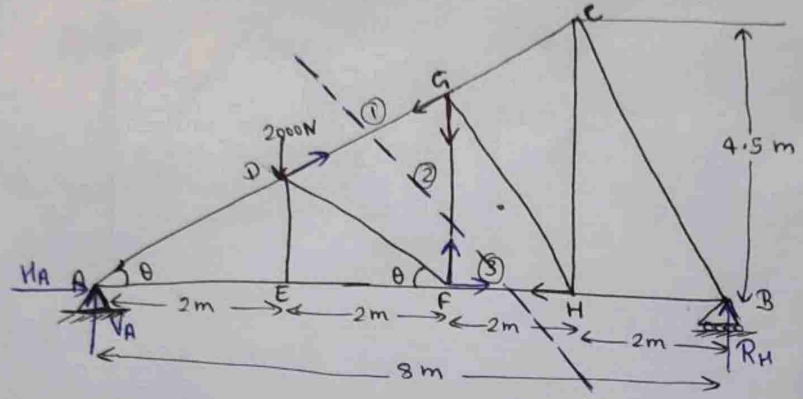
$-F_{EF} - F_{ED} \cos 30^\circ = 0$

$F_{EF} = -(-1200) \times \frac{\sqrt{3}}{2}$

$= 600\sqrt{3}$

$F_{EF} = 1039.23\,N$

5 - A plan truss is loaded and supported. Determine the nature and magnitude of forces in members 1, 2 and 3.



sol' - $\Sigma F_x = 0$, $H_A = 0$

$\Sigma F_y = 0$, $V_A + R_H = 2000\ N$

$\Sigma M_A = 0$,

$+(R_H \times 8) - (2000 \times 2) = 0$

$R_H = 500\ N$ / $\quad V_A = 1500\ N$ /

Applying method of section -

$\Sigma M_G = 0$

$(F_3 \times G_1F) + (2000 \times 2) - (1500 \times 4) = 0$

$F_3 = \frac{2000}{3.00} = 666.66\ kN.$ /

$\tan\theta = \frac{4.5}{6}$

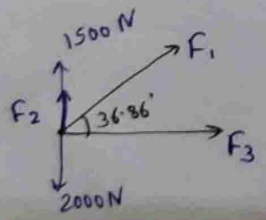
$\theta = 36.86°$ /

$\tan 29.35' = \frac{G_1F}{4}$

$\therefore G_1F = 4 \times \tan 36.86'$

~~$G_1F = 3.00$~~ /

$G_1F = 3.00\ m$



$\Sigma F_x = 0$,

$F_1 \cos 36.86' + F_3 = 0$

$F_1 = -\frac{F_3}{\cos(36.86')}$

$= -\frac{666.66}{0.800}$

$F_1 = -833.34\ N$ /

$\Sigma F_y = 0$,

$F_2 + 1500 + F_1 \sin 36.86 - 2000 = 0$

$F_2 = 500 + 833.34 \times \sin 36.86$

$= 500 + 499.88$

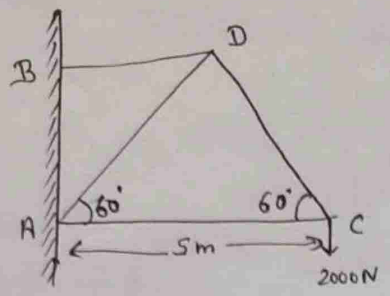
$F_1 = 1000\ N$ /

$\therefore F_1 = 833.34\ N$ (comp.)

$F_2 = 1000\ N$ (Tens.)

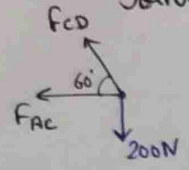
$F_3 = 666.66\ N$ (Tens.)

6- Determine the forces in all members of a cantilever truss-



sol^n-

Joint C-



$\Sigma F_x = 0$,

$-F_{AC} - F_{CD}\cos 60° = 0$

$F_{AC} = -2309.4/2$

$F_{AC} = -1154.7$ N

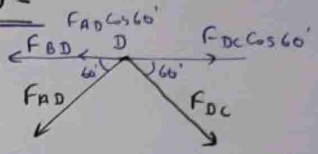
$\Sigma F_y = 0$,

$F_{CD}\sin 60° = 2000$

$F_{CD} = 4000/\sqrt{3}$

$F_{CD} = 2309.4$ N

Joint D-



$\Sigma F_x = 0$,

$-F_{BD} - F_{AD}\cos 60° + F_{DC}\cos 60° = 0$

$2F_{DC}\cos 60° = F_{BD}$

$F_{BD} = F_{DC}$

$F_{BD} = 2309.4$ N

$\Sigma F_y = 0$, $F_{DC}\sin 60° + F_{AD}\sin 60° = 0$

$F_{AD} = -F_{DC}$

so, $F_{AD} = -2309.4$ N

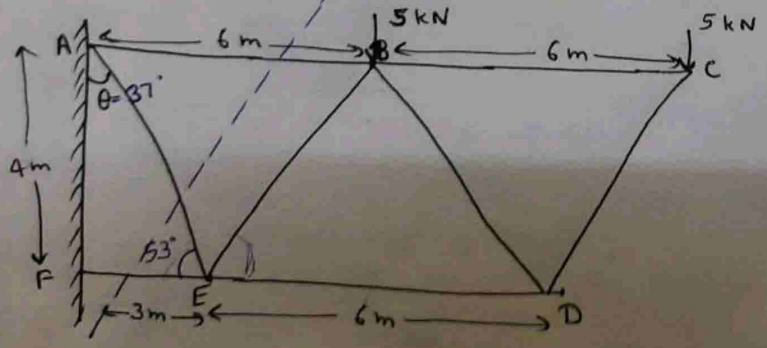
so, AC = 1154.7 N (Comp.)

CD = 2309.4 N (Tens.)

BD = 2309.4 N (Tens.)

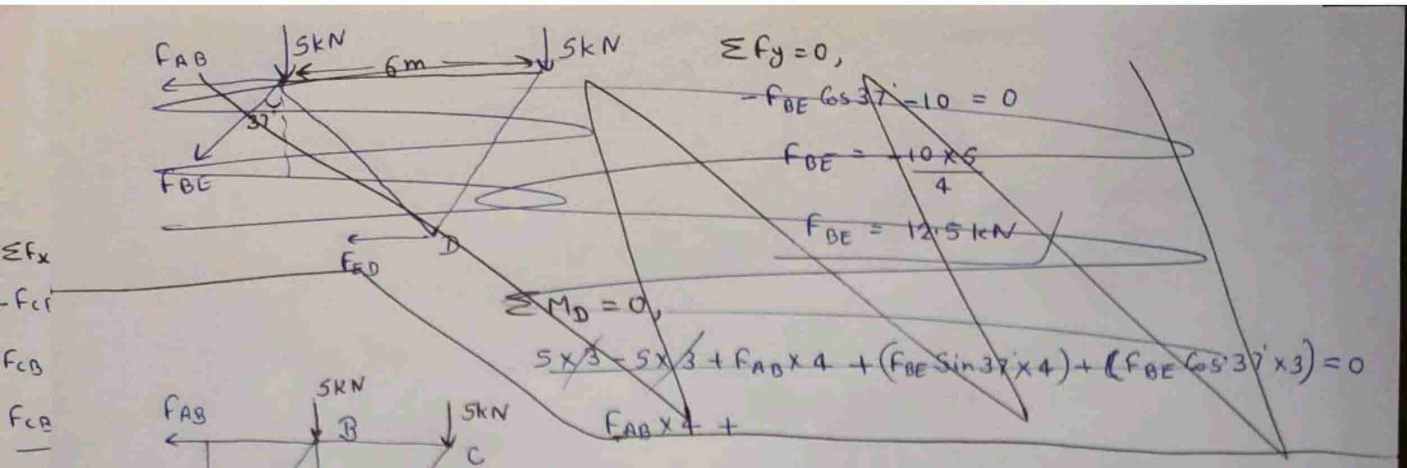
AD = 2309.4 N (Comp.)

7- Find the force in member AB-



$\tan\theta = 3/4$

$\theta = 37°$



$\Sigma F_y = 0,$

$-F_{BE}\cos 37° - 10 = 0$

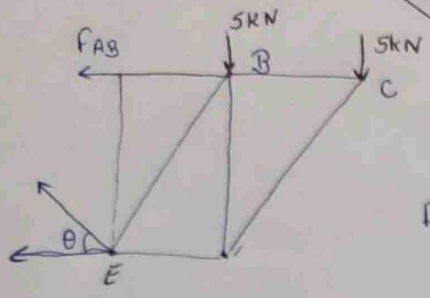
$F_{BE} = \frac{+10 \times 5}{4}$

$F_{BE} = 12.5\ kN$

$\Sigma M_D = 0,$

$5\times3 - 5\times3 + F_{AB}\times4 + (F_{BE}\sin 37°\times4) + (F_{BE}\cos 37°\times3) = 0$

$F_{AB}\times4 +$



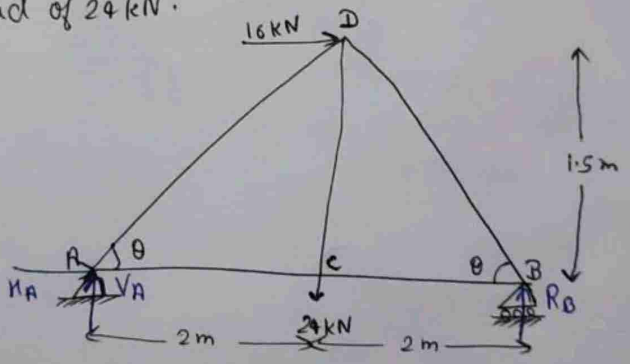
$\Sigma M_E = 0,$

$F_{AB}\times4 = 5\times3 + 5\times9$

$= 15 + 45$

$F_{AB} = \frac{60}{4} = 15\ kN$

8- Determine the forces in the truss, which carries a horizontal load of 16kN and vertical load of 24kN.



sol^n - $\Sigma F_x = 0,$ $H_A = 16\ kN$

$\Sigma F_y = 0,$

$V_A + R_B = 24kN$ ——— (i)

$\Sigma M_A = 0,$

$[16(1.5)] - (24\times2) + R_B\times4 = 0$

$R_B = 18kN$ from eq^n (i)

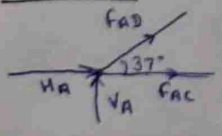
$V_A = 6\ kN$

$\tan\theta = \frac{1.5}{2}$

$= 3/4$

$\theta = 37°$

Joint-A



$\Sigma F_x = 0,$

$H_A + F_{AD}\cos 37° + F_{AC} = 0$

$-16 + F_{AD}\times\frac{4}{5} + F_{AC} = 0$

$4F_{AD} + 5F_{AC} = 80$ ——— (ii)

put F_{AD} in eq^n (ii) -

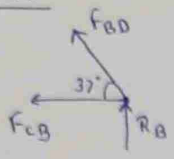
$4(-10) + 5F_{AC} = 80$

$F_{AC} = 120/5 = 24\ kN$

$\Sigma F_y = 0,$ $V_A + F_{AD}\sin 37° = 0$

$F_{AD} = \frac{-6}{\sin 37°}$, $F_{AD} = -10kN$

Joint - B -



$\Sigma F_x = 0$,

$-F_{CB} - F_{BD}\cos 37° = 0$

$F_{CB} = -(-30) \times 4/5$

$F_{CB} = 24$ kN

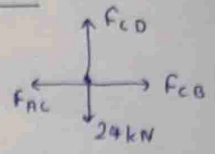
$\Sigma F_y = 0$

$R_B + F_{BD}\sin 37° = 0$

$F_{BD} = -\frac{18}{\sin 37°}$

$F_{BD} = -30$ kN

Joint - C



Resolving force along DC -

$F_{CD} = 24$ kN

10, AC = 24 kN (Tens)

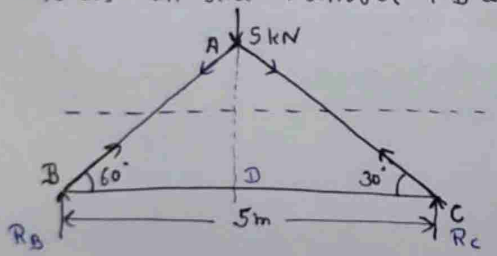
AD = 10 kN (comp)

CD = 24 kN (Tens.)

CB = 24 kN (Tens.)

BD = 30 kN (comp.)

9- Find the forces in the member AB and AC of the truss using method of section.



sol^n - First determine R_B & R_C -

$\Sigma F_y = 0$, $R_B + R_C = 5$ kN ——(i)

$\Sigma M_B = 0$,

$R_C \times 5 - 5 \times 1.25 = 0$

$R_C = \frac{5 \times 1.25}{5}$, $R_C = 1.25$ kN

from eq^n (i)

$R_B = 3.75$ kN

$\because \triangle ABC$ is right angle $\triangle$.

$\therefore AB = BC\cos 60°$

$= 5\cos 60°$

$BD = (5\cos 60°)\cdot\cos 60°$

$= 5/4 = 1.25$ m

$AD = AB\sin 60°$

$= (5\cos 60°)\cdot\sin 60°$

$AD = 2.16$ m

Applying method of section -

$\Sigma M_B = 0$,

$(R_C \times 5) + F_{AC}(AB) = 0$

$1.25 \times 5 = -F_{AC}(2.5)$

10, $F_{AC} = -\left(\frac{1.25 \times 5}{2.5}\right)$

$F_{AC} = -2.5$ kN

$\Sigma F_x = 0$,

$F_{AB}\cos 60° - F_{AC}\cos 30° = 0$

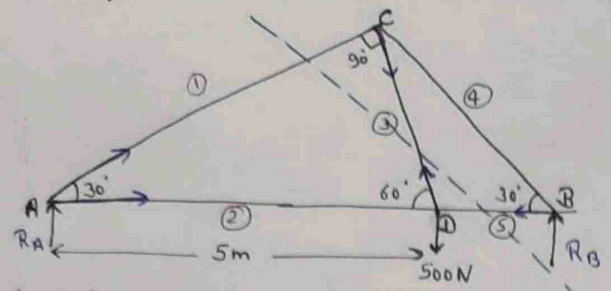
$F_{AB} = \frac{(-2.5)(\sqrt{3})}{\frac{1}{2} \times 2}$

$F_{AB} = -4.33$ kN

10, AB = 4.33 kN (comp)

AC = 2.5 kN (comp.)

10- Find the forces in the members 1, 3, 5 of truss, using method of section.



sol:- First determine R_A & R_B -

$\Sigma F_y = 0$, $R_A + R_B = 500\ N$ ——— (i)

$\Sigma M_A = 0$, $R_B \times 7.5 - 500 \times 5 = 0$

$\therefore R_B = \frac{2500}{7.5} = 333.33\ N$

from eq^n (i)

$R_A = 500 - 333.33$

$R_A = 166.67\ N$

Applying method of section -

$\Sigma M_C = 0$,

$(-R_A \times 5) - F_1 \times CD = 0$

$(CD = 5\cos 60^\circ)$

$F_1 = -\left(\frac{166.67 \times 5}{5\cos 60^\circ}\right)$

$F_1 = -333.34\ kN$

$\Sigma F_y = 0$ - at D -

$F_1 \sin 30^\circ + F_3 \sin 60^\circ = 500 - R_A$

after solving -

$F_3 = 577.35\ kN$

so, $F_1 = 333.34$ (comp.)

$F_2 = 577.35$ (Tens.)

$\Sigma F_x = 0$ -

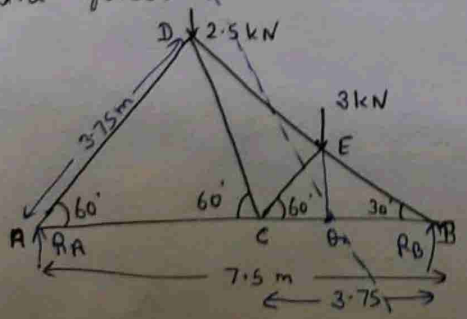
$F_1 \cos 30^\circ + F_2 - F_3 \cos 60^\circ = 0$

$F_2 = F_3 \cos 60^\circ - F_1 \cos 30^\circ$

$= 288.675 + 288.675$

$F_2 = 577.35\ kN$

11- Find the forces in the members DE, CE and CB of the truss.

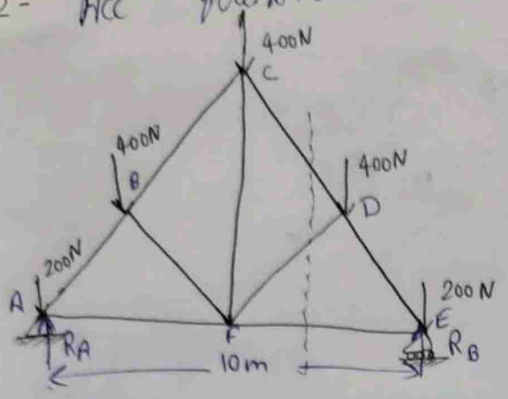


$R_A = 3\ kN$

$R_B = 2.5\ kN$

(from 3rd question)

12- Acc^to question -



From q^n a -

$\therefore R_A = 800N$ & $R_B = 800N$

applying section method -

$\Sigma M_D = 0,$

$\left(f_{EF} \times \frac{5}{2\sqrt{3}}\right) + \left(200 \times \frac{5}{2}\right) = \left(800 \times \frac{5}{2}\right)$

$f_{EF} = 600\sqrt{3}N \Leftrightarrow$ **$f_{EF} = 1032.23N$ / (T)**

Now, $\Sigma M_E = 0,$

$\Rightarrow \left(f_{CD} \times \frac{5}{2}\right) + (800 \times 5) = \left(400 \times \frac{5}{2}\right) + (200 \times 5)$

$\therefore f_{CD} = -(2 \times 400)N \Leftrightarrow$ **$f_{CD} = 800N$ (c)**

Now, $\Sigma M_E = 0,$

$\left(f_{DE} \times \frac{1}{2} \times \frac{5}{2}\right) + \left(f_{DF} \times \frac{\sqrt{3}}{2} \times \frac{5}{2\sqrt{3}}\right) + \left(400 \times \frac{5}{2}\right) = 0$

$\therefore f_{DE} = -(2 \times 200)N \Leftrightarrow$ **$f_{DE} = 400N$ (c)**

10, $f_{EF} = 1039.23N$ (T)

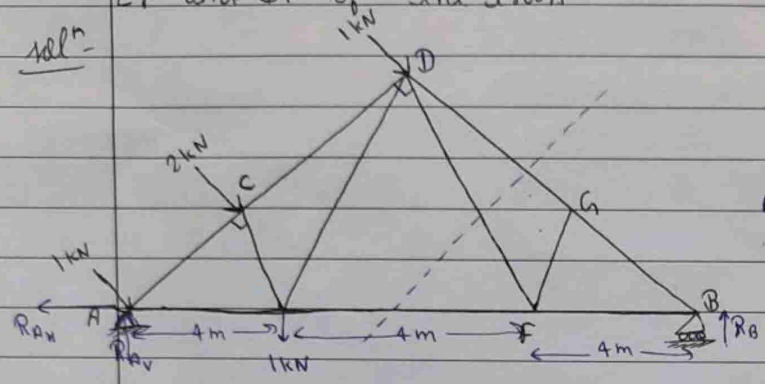
$f_{CD} = 800N$ (c)

$f_{DF} = 400N$ (c)

Topic : ..... Date : ..... Page No. : .....

13- Using section method, determine the forces in members GD, EF and DF of the truss-

sol^n-



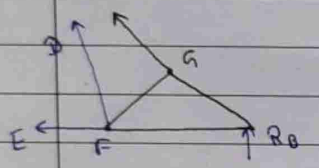
AC = AE Cos 30°
= 3.464 m

AD = 8 Cos 30° = 6.928 m

$\Sigma M_A = 0$,

$R_B(12) = (2 \times 3.464) + (1 \times 6.928) + 1 \times 4$

$R_B = 1.49$ kN



$\Sigma M_F = 0$,

$R_B \times 4 + F_{DG} \times FG = 0$

$1.49 \times 4 + F_{DG}(4 \sin 30°) = 0$

$F_{DG} = 2.98$ (C)

$\Sigma M_D = 0$.

$R_B \times BD \cos 30° = F_{FE} \times BD \sin 30°$

$F_{FE} = \frac{1.49 \times \cos 30°}{\sin 30°} = 2.58$ kN (T)

$\Sigma M_B = 0$,

so all dist^n b/w F_{FD} and B is not zero

so, $F_{FD} = 0$

so, $F_{DG} = 2.98$ kN (C)

$F_{EF} = 2.58$ kN (T)

$F_{FD} = 0$ kN Nil.