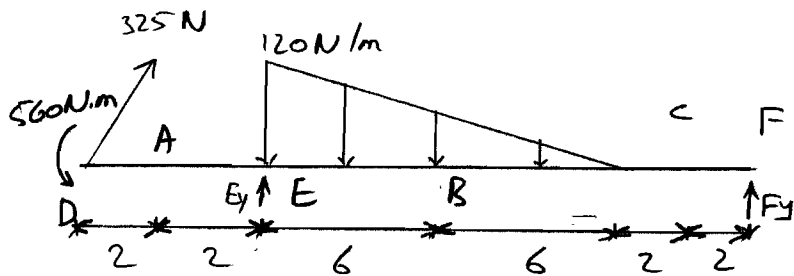


Problem 1: -



Given: - Fig P1.

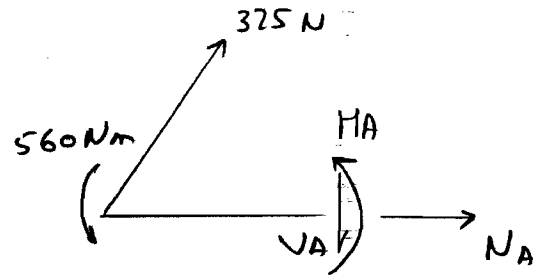
Required: Internal forces at A, B & C

Solution: - AT A:

$$\sum F_y = 0$$

$$325 \left( \frac{12}{13} \right) - U_A = 0$$

$$U_A = 300 \text{ N}$$



$$\sum F_x = 0$$

$$+ 325 \left( \frac{5}{13} \right) + N_A = 0$$

$$N_A = 125 \text{ N "C"}$$

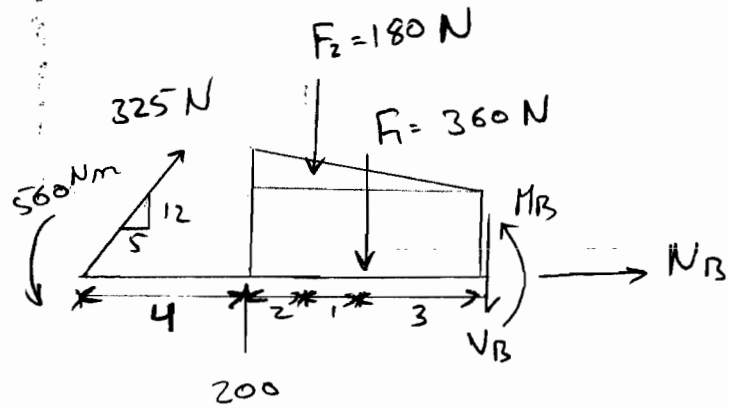
$$\sum M_A = 0$$

$$+ 560 + 325 \left( \frac{5}{13} \right) (0) - 325 \left( \frac{12}{13} \right) (2) + M_A = 0$$

$$M_A = -40 \text{ N.m}$$

(2)

AT B :-



Note :- Take the Left part although the right part seems easier. (Why?!)

First we have to find the reaction  $E_y$

$$\uparrow \sum M_F = 0$$

$$(720)(12) - (E_y)(6) + 560 - (325)\left(\frac{12}{13}\right)(20) = 0$$

$$E_y = 200 \text{ N}$$

Note :- No need to Find the other reactions (Why?!)

$$F_1 = 6(60) = 360 \text{ N}$$

$$F_2 = \frac{6}{2}(120 - 60) = 180 \text{ N}$$

$$\rightarrow \sum F_x = 0$$

$$(325)\left(\frac{5}{13}\right) + N_B = 0,$$

$$N_B = 125 \text{ N "C"}$$

$$\uparrow \sum F_y = 0$$

$$(325)\left(\frac{12}{13}\right) - 180 - 360 + 200 - V_B = 0,$$

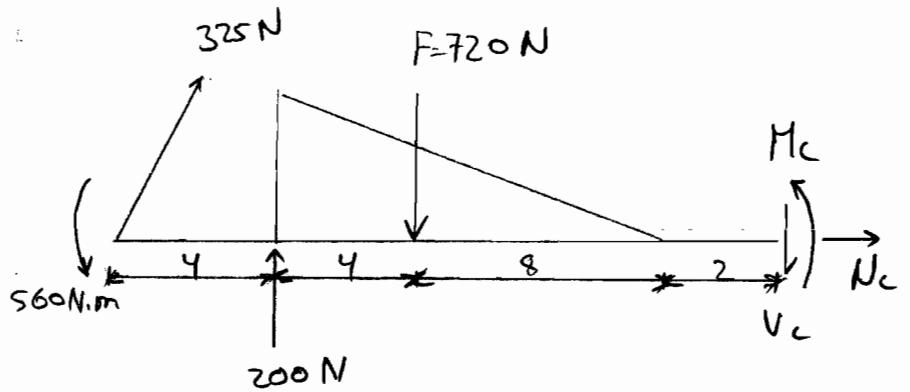
$$V_B = -40 \text{ N}$$

$$+\downarrow \Sigma M_B = 0$$

$$560 - 325 \left( \frac{12}{13} \right) (10) - 200(6) + (180)(4) + (360)(3) + M_B = 0$$

$$M_B = 1840 \text{ N.m}$$

AT C :-



$$+\uparrow \Sigma F_y = 0$$

$$325 \left( \frac{12}{13} \right) + 200 - 720 - V_c = 0$$

$$V_c = -220 \text{ N}$$

$$\Sigma F_x = 0$$

$$325 \left( \frac{5}{13} \right) + N_c = 0$$

$$N_c = 125 \text{ N "C"}$$

$$+\downarrow \Sigma M_C = 0$$

$$- 325 \left( \frac{12}{13} \right) (18) - 200(14) + 720(10) + 560 + M_C = 0$$

$$M_C = 440 \text{ N.m}$$

(4)

Problem 2:-

Given: Fig P2

Required: Internal forces at C

Solution:-

$$\sum \vec{F} = 0$$

$$\vec{F}_C + \vec{F}_1 + \vec{F}_2 = 0$$

$$\vec{F}_C + 350\vec{i} - 400\vec{j} - 300\vec{j} + 150\vec{k} = 0$$

$$\vec{F}_C = -350\vec{i} + 700\vec{j} - 150\vec{k} \text{ (N)}$$

$F_{Cx} = N_x = 350 \text{ N "C"}$ $F_y = V_y = 700 \text{ N}$ $F_z = N_z = -150 \text{ N}$
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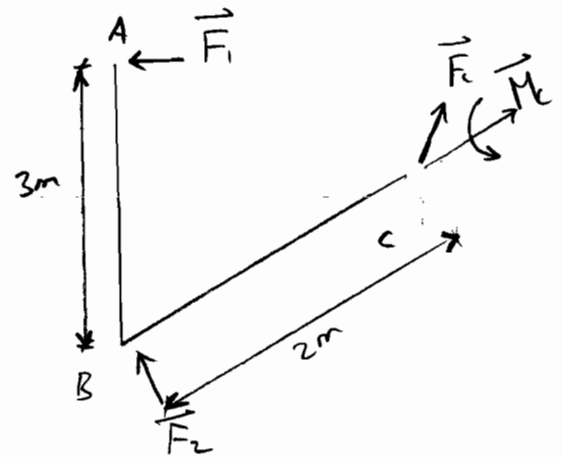
$$\sum \vec{M}_C = 0$$

$$\vec{M}_C + (\vec{r}_{CA} \times \vec{F}_1) + (\vec{r}_{CB} \times \vec{F}_2) = 0$$

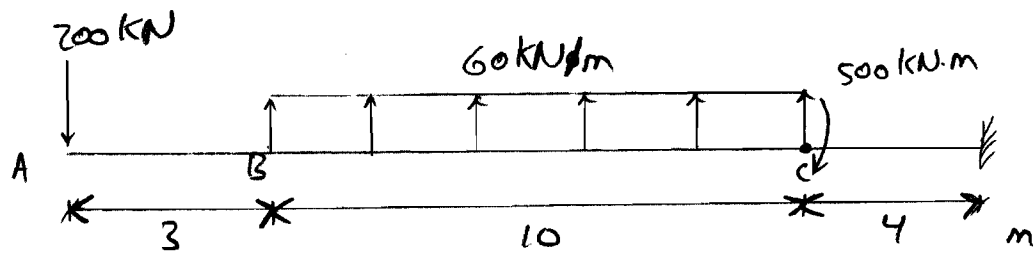
$$\vec{M}_C = - \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 2 & 0 & 3 \\ 350 & -400 & 0 \end{vmatrix} - \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 2 & 0 & 0 \\ 0 & -300 & 150 \end{vmatrix}$$

$$\vec{M}_C = - (1200\vec{i} + 1050\vec{j} - 800\vec{k}) + 300\vec{j} + 600\vec{k}$$

$\vec{M}_C = -1200\vec{i} - 750\vec{j} + 1400\vec{k}$
---



Problem 3:



Given: Fig P3

Required: Equations & drawing of shear force & Bending moment diagrams.

Solution:

Note: No Need to Find the reactions (Why?)

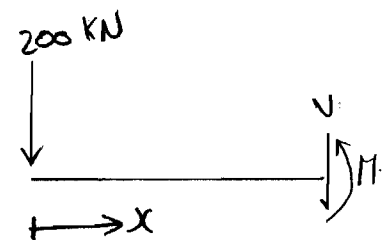
Section AB  $\rightarrow$  AB ( $0 \leq x \leq 3m$ )

$$\uparrow \sum F_y = 0$$

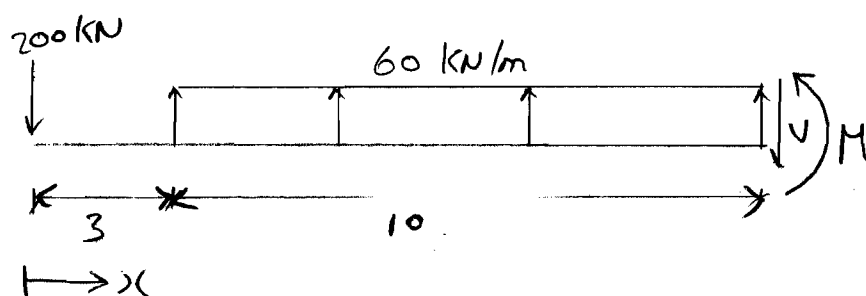
$$V = -200 \text{ kN}$$

$$\downarrow \sum M = 0$$

$$M = -200x \text{ (kNm)}$$



Section BC ( $3 \leq x \leq 13$ )



$$\uparrow \Sigma F_y = 0$$

$$-200 - V + 60(x-3) = 0$$

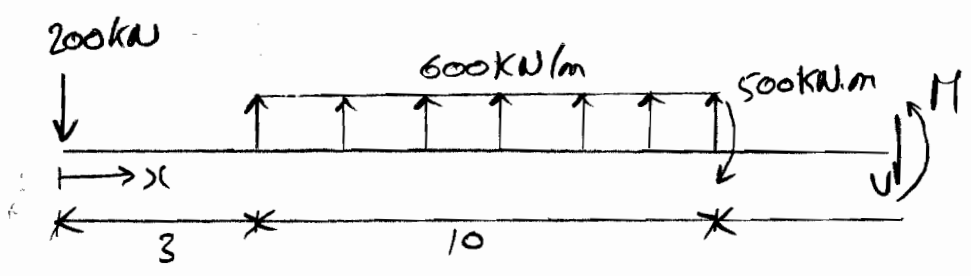
$$V = 60x - 380 \text{ kN}$$

$$\downarrow \Sigma M = 0$$

$$M + 200x - 60(x-3) \frac{(x-3)}{2}$$

$$M = 30x^2 - 380x + 270 \text{ kN.m}$$

section CD  $\Rightarrow (13 \leq x \leq 17)$

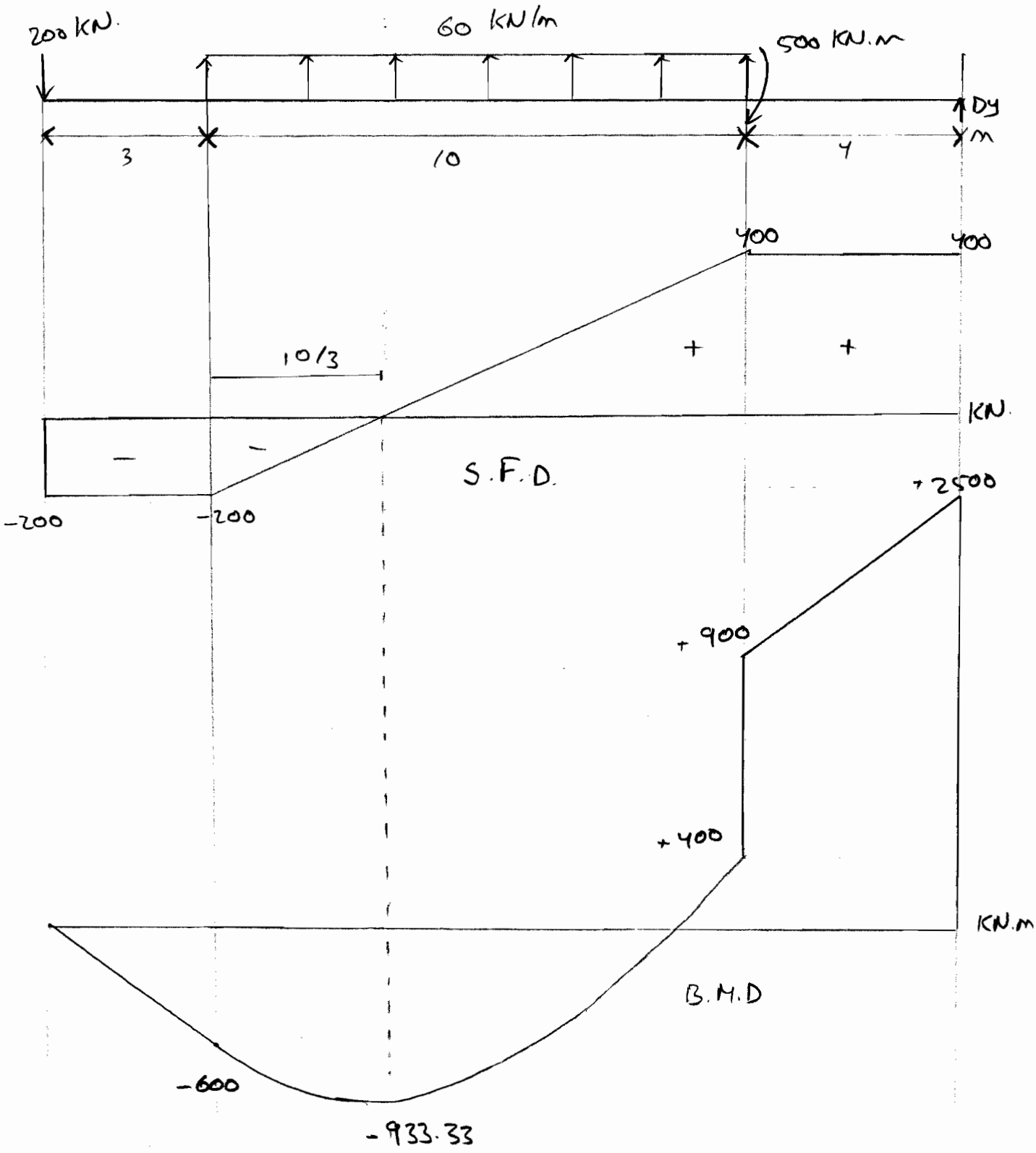


$$\uparrow \Sigma F_y = 0 \Rightarrow V = 400 \text{ kN}$$

$$\downarrow \Sigma M = 0$$

$$M + 200x - 600(x-8) - 500 = 0$$

$$M = 400x - 4300$$

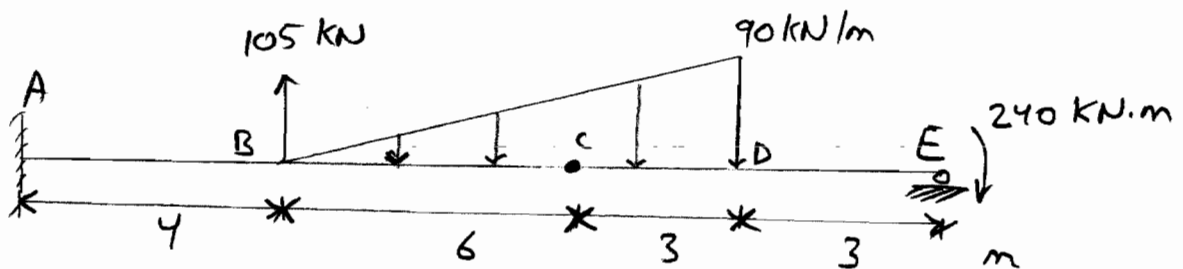


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Problem 4:-

Given: Fig P4

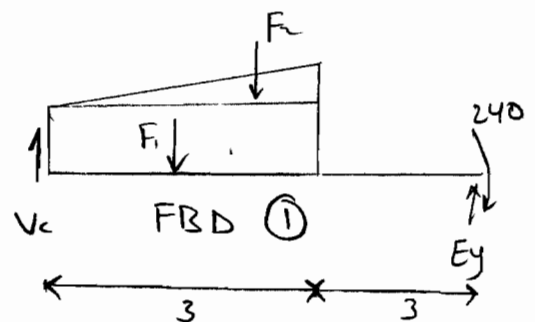
Required: Equation, SFD & BMD.



Solution:- FBD ①

$$F_1 = 60(3) = 180 \text{ kN}$$

$$F_2 = (90 - 60)(3/2) = 45 \text{ kN}$$



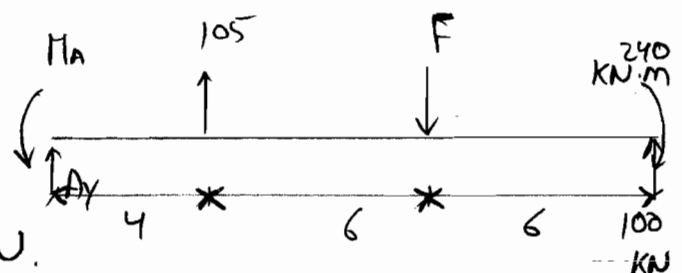
$$\sum M_c = 0$$

$$6E_y - 180(1.5) - 45(2) - 240 = 0$$

$$E_y = 100 \text{ kN}$$

FBD ②

$$F = 90(9/2) = 405 \text{ kN}$$



$$\sum F_y = 0$$

$$A_y + 105 - 405 + 100 = 0$$

$$\Rightarrow A_y = 200 \text{ kN}$$



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$$\downarrow \sum M_A = 0$$

$$M_A + 105(4) - 405(10) + 100(16) - 240 = 0$$

$$M_A = 2270 \text{ KN.m}$$

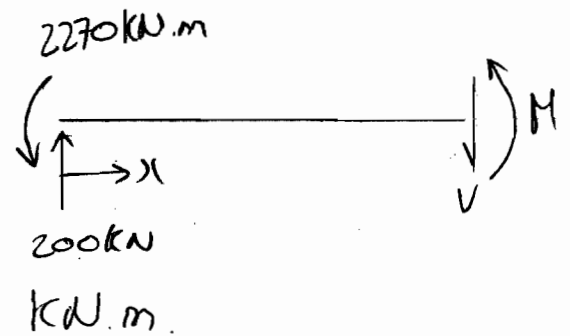
Section AB ( $0 \leq x \leq 4$ )

$$\uparrow \sum F_y = 0$$

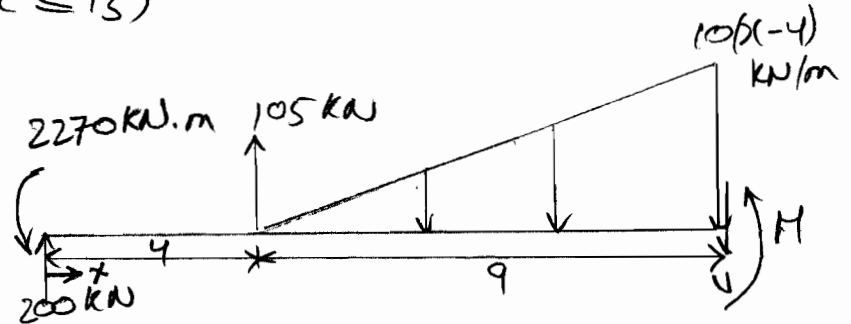
$$V = 200 \text{ KN}$$

$$\downarrow \sum M = 0$$

$$M = -2270 + 200x$$



Section BD ( $4 \leq x \leq 13$ )



$$\uparrow \sum F_y = 0$$

$$200 + 105 - 10(x-4)\left(\frac{x-4}{2}\right) - V = 0$$

$$V = 305 - 5(x-4)^2$$

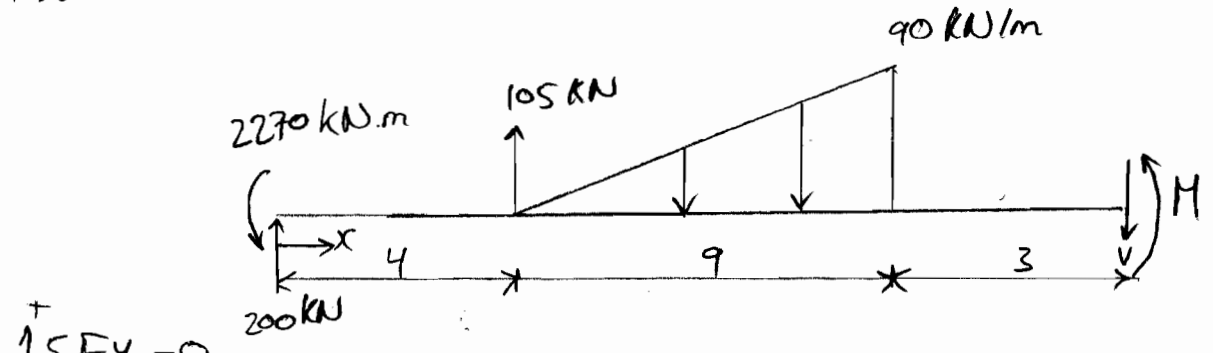
$$V = -5x^2 + 40x + 225$$

$$\downarrow \sum M = 0$$

$$M + 2270 - 200x - 105(x-4) + 10(x-4)\left(\frac{x-4}{2}\right)\left(\frac{x-4}{3}\right) = 0$$

$$M = -\frac{5x^3}{3} + 20x^2 + 225x - \frac{7750}{3}$$

section DE ( $13 \leq x \leq 16$ )



$$\uparrow \sum F_y = 0$$

$$200 + 105 - 405 - V = 0$$

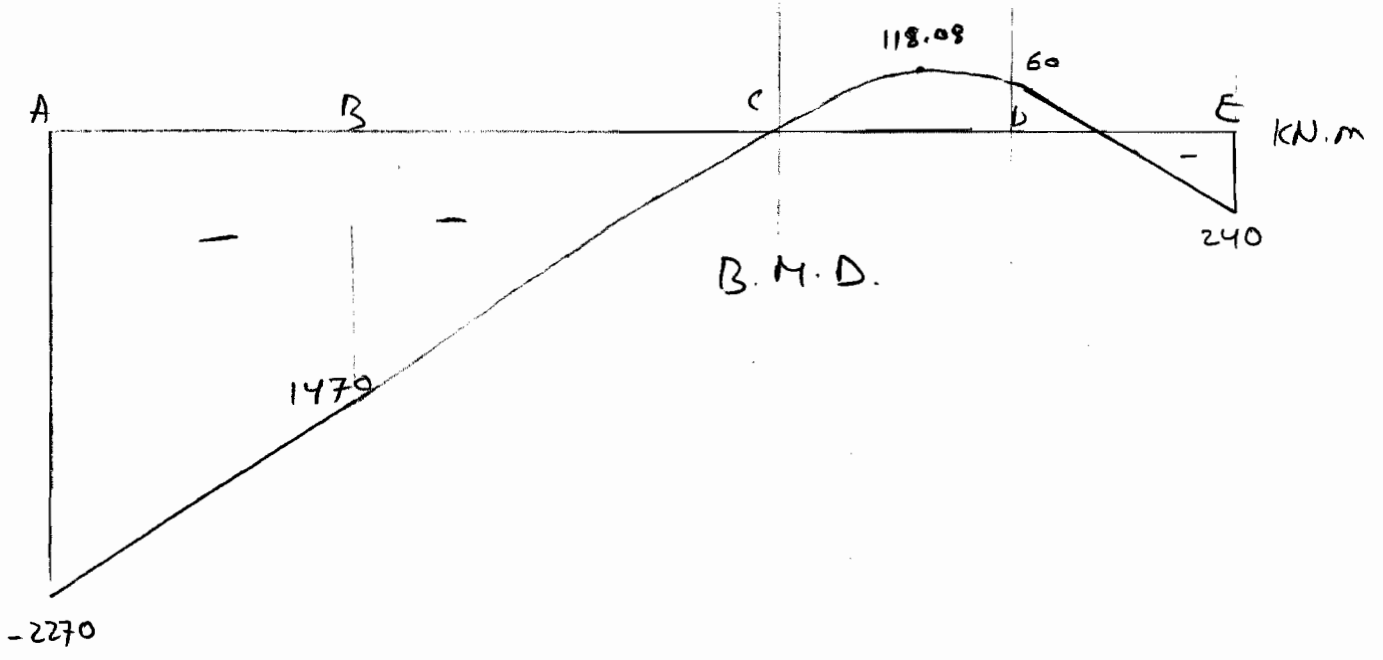
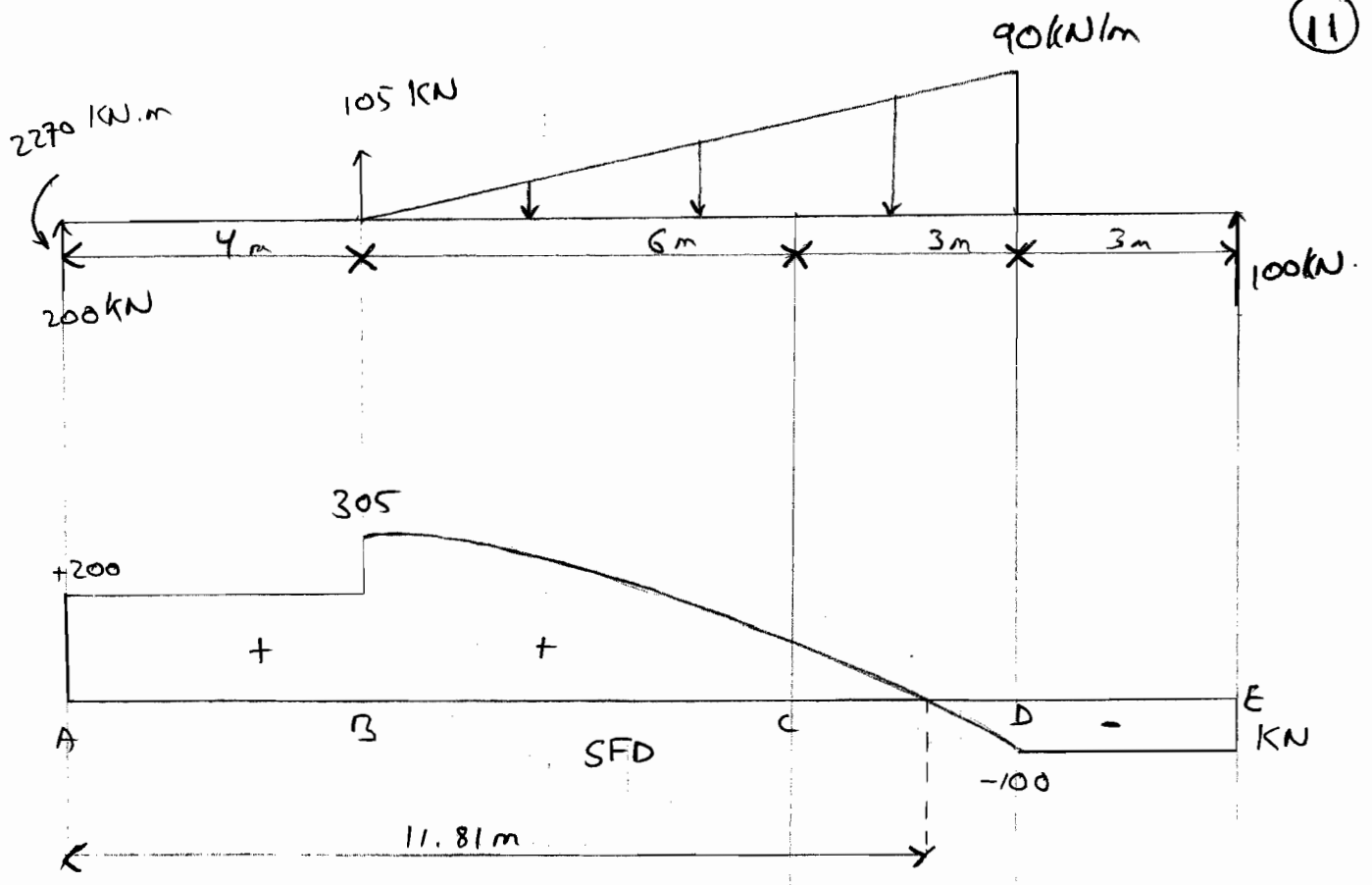
$$V = -100 \text{ kN}$$

$$\downarrow \sum M = 0$$

$$(405)(16-10) - (105)(x-4) + 2270 - 200x + M = 0$$

$$M = -100x + 1360$$



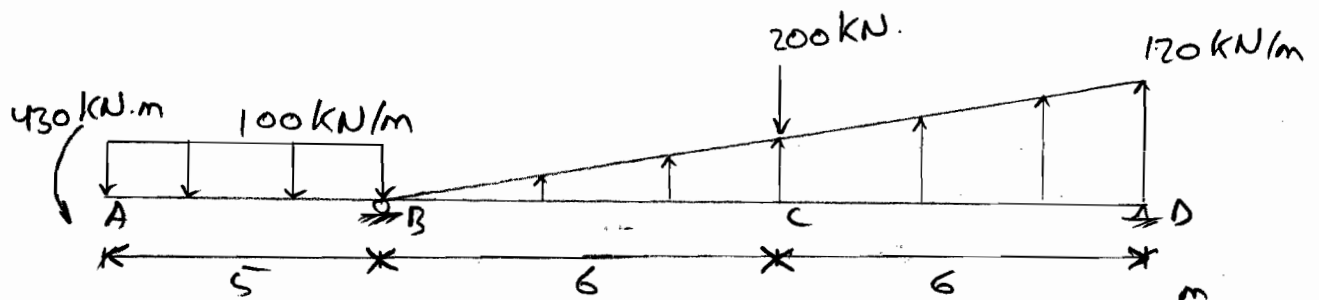




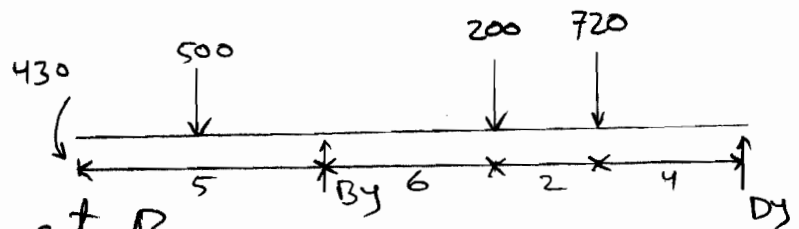
Problem 5:-

Given: Fig P4

Required: Equations, SFD & BMD.



Solution.



Finding Reaction at B

$$\sum M_D = 0$$

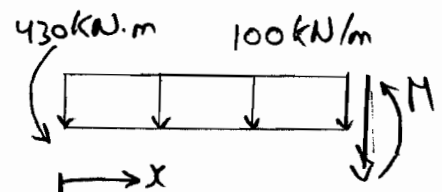
$$430 + 500(14.5) - B_y(12) + 200(6) - 720(4) = 0$$

$$B_y = 500 \text{ kN.}$$

Section AB ( $0 \leq x \leq 5$ )

$$\sum F_y = 0$$

$$V = -100x \text{ kN}$$



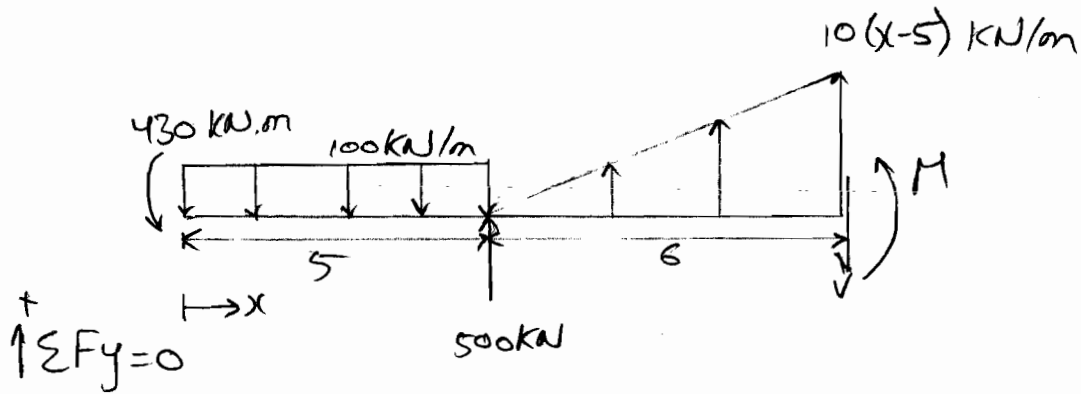
$$\sum M = 0$$

$$M + 430 + (100)(x)(x/2)$$

$$M = -50x^2 - 430 \text{ kN.m}$$



Section BC ( $5 \leq x < 11$ )



$$-500 + 500 + \frac{10}{2}(x-5)(x-5) - V = 0$$

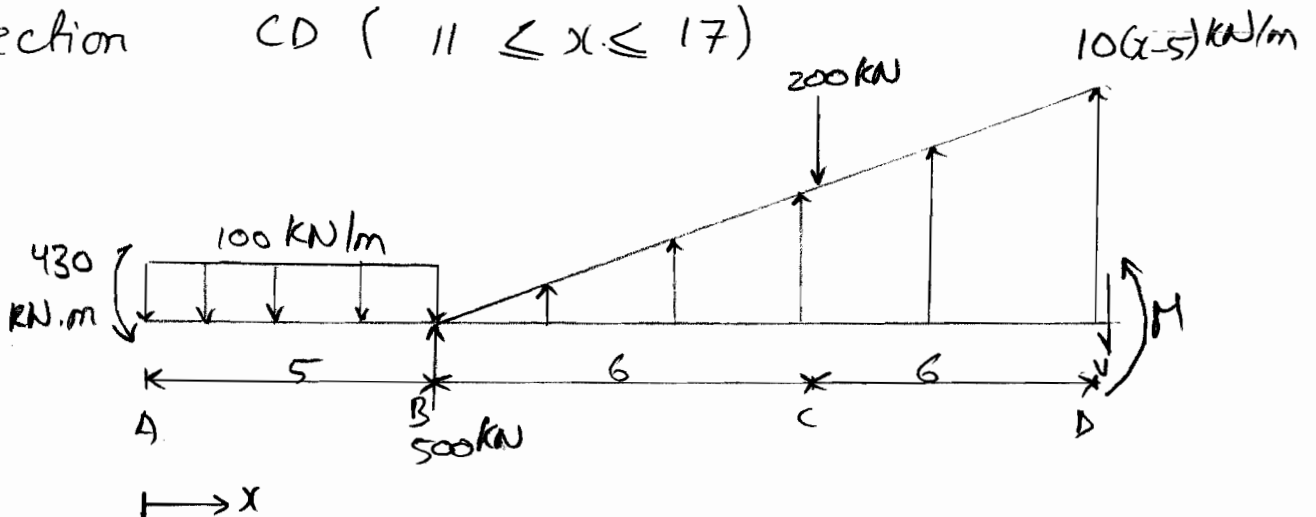
$$V = 5(x-5)^2 \text{ KN}$$

$$+\sum M = 0$$

$$M + 430 + 500(x-2.5) - 500(x-5) - 5(x-5)^2 \frac{(x-5)}{3} = 0$$

$$M = \frac{5}{3}x^3 - 25x^2 + 125x - \frac{5665}{3} \text{ KN.m}$$

Section CD ( $11 \leq x \leq 17$ )





(14)

$$\uparrow \Sigma F_y = 0$$

$$+500 + 500 - 200 + 10/2 (x-5)(x-5) - U = 0$$

$$U = 10/2 (x-5)^2 - 200 \text{ kN}$$

$$\curvearrowleft \Sigma M = 0$$

$$M + 430 + 500(1-2.5) - 500(1-5) + \frac{10}{2}(x-5)^2 \left(\frac{x-5}{3}\right) - 200(x-11) = 0$$

$$M = \frac{5}{3}x^3 - 25x^2 + 75x - 311.667 \text{ kN}\cdot\text{m}$$

