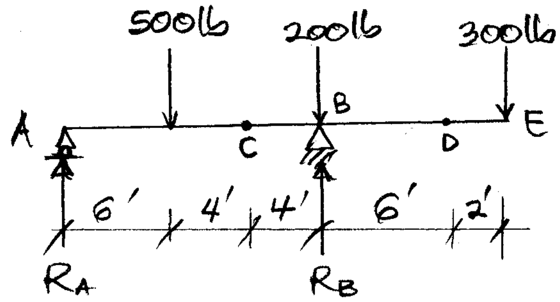
CE 202 — HW #6

#1. Frist obtain support reactions



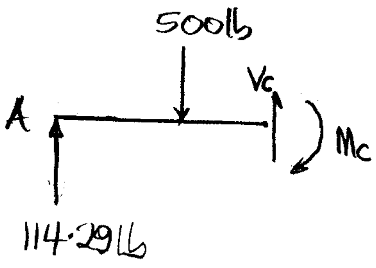
$$\sum M_B = -14R_A + 8(500) - 8(300) = 0$$

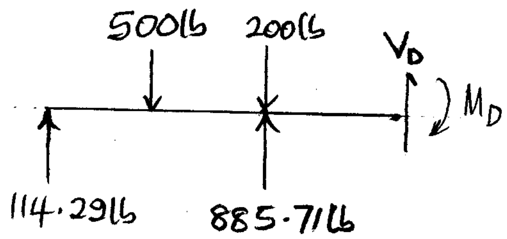
$$-14R_A + 1600 = 0 \Rightarrow R_A = \frac{800}{7} - 114.29\,lb$$

$$\sum F_y = \frac{800}{7} - 500 + R_B - 200 - 300 = 0$$

$$R_B = \frac{6200}{7} = 885.71\ lb$$

Now at C





$\sum F_y = 0$ gives $V_c = 500 - 114.29$

$\therefore V_c = 385.71\ lb$

$$\sum M_c = -114.29(10) + 500(4) - M_c = 0$$

$$\Rightarrow M_c = 857.14\ lb\text{-}ft$$

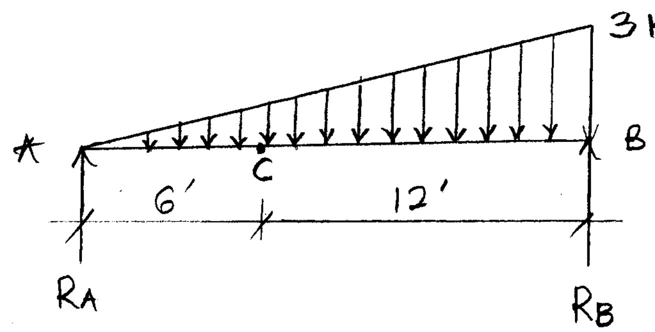
$$\sum F_y = \frac{800}{7} - 500 + \frac{6200}{7} - 200 + V_D = 0$$

$$\Rightarrow V_D = -300\,lb$$

$$\sum M_D = -\frac{800}{7}(20) + 500(14) - \frac{6200}{7}(6) + 200(6) - M_D = 0$$

$$\Rightarrow M_D = 600\ lb\text{-}ft$$

#2



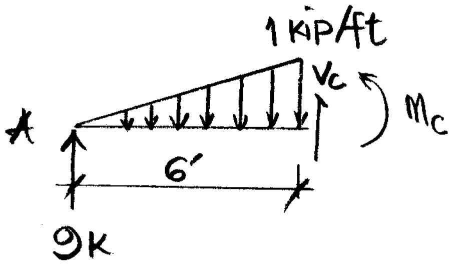
$\Sigma M_B = -18R_A + 0.5(18)(3)(6) = 0$

$-18R_A + 162 = 0 \Rightarrow R_A = 9$ kips

$\Sigma F_y = 9 - 0.5(18)(3) + R_B = 0$

$9 - 27 + R_B = 0 \Rightarrow R_B = 18$ kips

At C



load intensity at C

$= \frac{6}{18} \times 3 = 1$ kip/ft

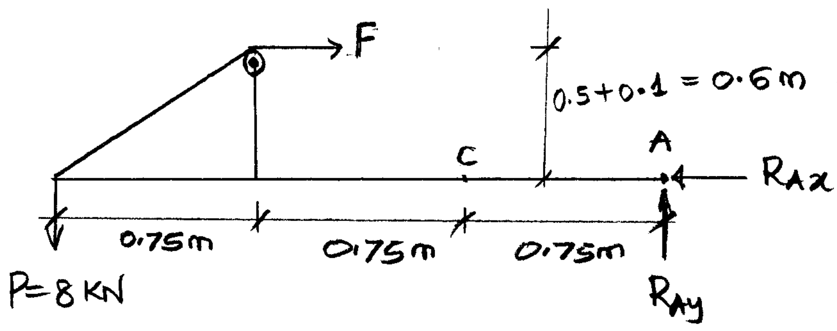
$\Sigma F_y = 9 - 0.5(6)(1) + V_c = 0 \Rightarrow V_c = -6$ kips

or $V_c = 6$ kips ↓

$\Sigma M_c = -9(6) + 0.5(6)(1)(2) + M_c = 0$

$-48 + M_c = 0 \Rightarrow M_c = 48$ kips-ft

#3



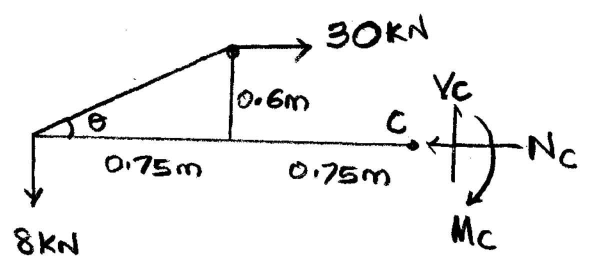
To determine the internal forces at C (N, V & M), finding the reactions at A is not required. But for the sake of knowing them,

$\Sigma M_A = 8(0.75)(3) - 0.6F = 0 \Rightarrow F = 30 KN$

$\Sigma F_x = 0$ gives $R_{Ax} = 30 KN$

$\Sigma F_y = 0$ gives $R_{Ay} = 8 KN$

Now the internal forces at C



$\Sigma F_x = 30 - N_c = 0$

$\Rightarrow N_c = 30 KN$

$\Sigma F_y = -8 + V_c = 0$

$\Rightarrow V_c = 8 KN$

$\Sigma M_c = 8(1.5) - 30(0.6) - M_c = 0$

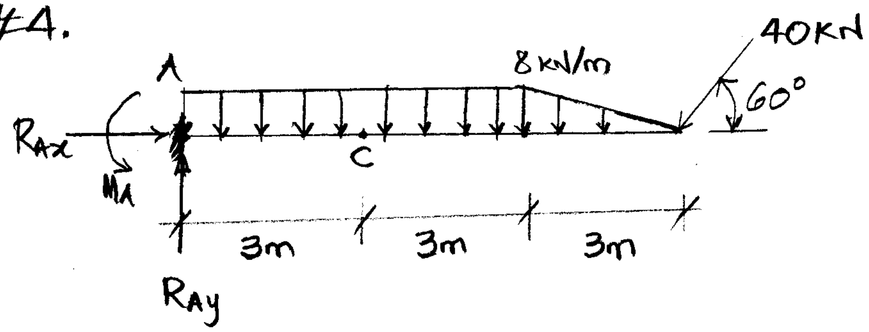
$12 - 18 - M_c = 0 \Rightarrow M_c = 6 KNm$

Hence, the normal force, shear force and moment at section passing through point C are

$N_c = 30 KN$, $V_c = 8 KN$ and $M_c = 6.0 KNm$

respectively.

#4.



$\Sigma F_x = R_{Ax} - 40\cos 60^\circ = 0 \Rightarrow R_{Ax} = 20\,\text{KN}$

$\Sigma F_y = R_{Ay} - 8(6) - 0.5(8)(3) - 40\sin 60^\circ = 0$

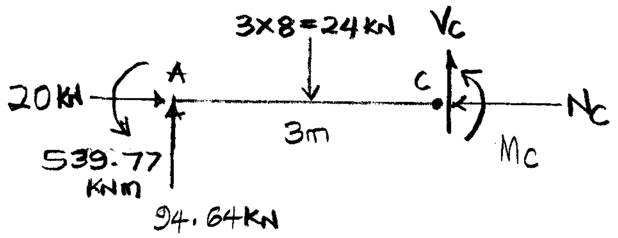
$R_{Ay} - 94.64 = 0 \Rightarrow R_{Ay} = 94.64\,\text{KN}$

$\Sigma M_A = M_A - 8(6)(3) - 0.5(8)(3)(7) - 40\sin 60^\circ(9) = 0$

$M_A - 144 - 84 - 311.77 = 0$

$M_A = 539.77\ \text{KNm}$

Now N_c, V_c & M_c at C



$\Sigma F_x = 20 - N_c = 0 \Rightarrow N_c = 20\,\text{KN}$

$\Sigma F_y = 94.64 - 24 + V_c = 0$

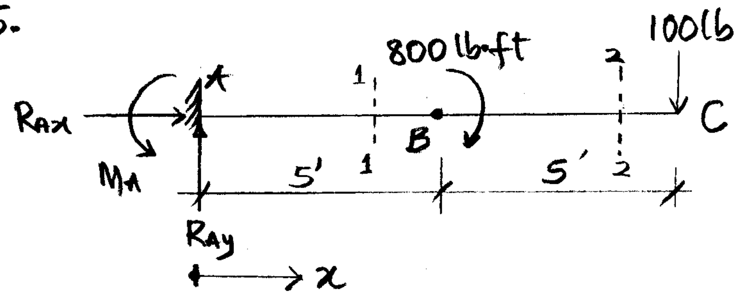
$V_c = -70.64\ \text{KN}$

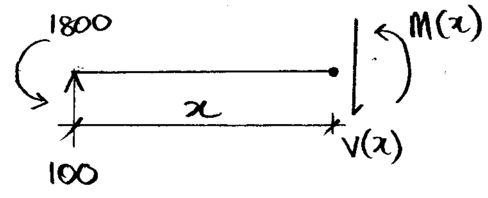
$\Sigma M_c = 408 - 94.64(3) + 24(1.5) - M_c = 0$

$291.85 - M_c = 0 \Rightarrow M_c = 291.85\ \text{KNm}$

Thus $N_c = 20\,\text{KN}$, $V_c = 74\,\text{KN}\downarrow$ & $M_c = 291.85\ \text{KNm}$

#5.





Section 1-1

$R_{Ax} = 0$

$\Sigma F_y = R_{Ay} - 100 = 0 \Rightarrow R_{Ay} = 100\ lb$

$\Sigma M_A = M_A - 800 - 100(10) = 0 \Rightarrow M_A = 1800\ lb\cdot ft$

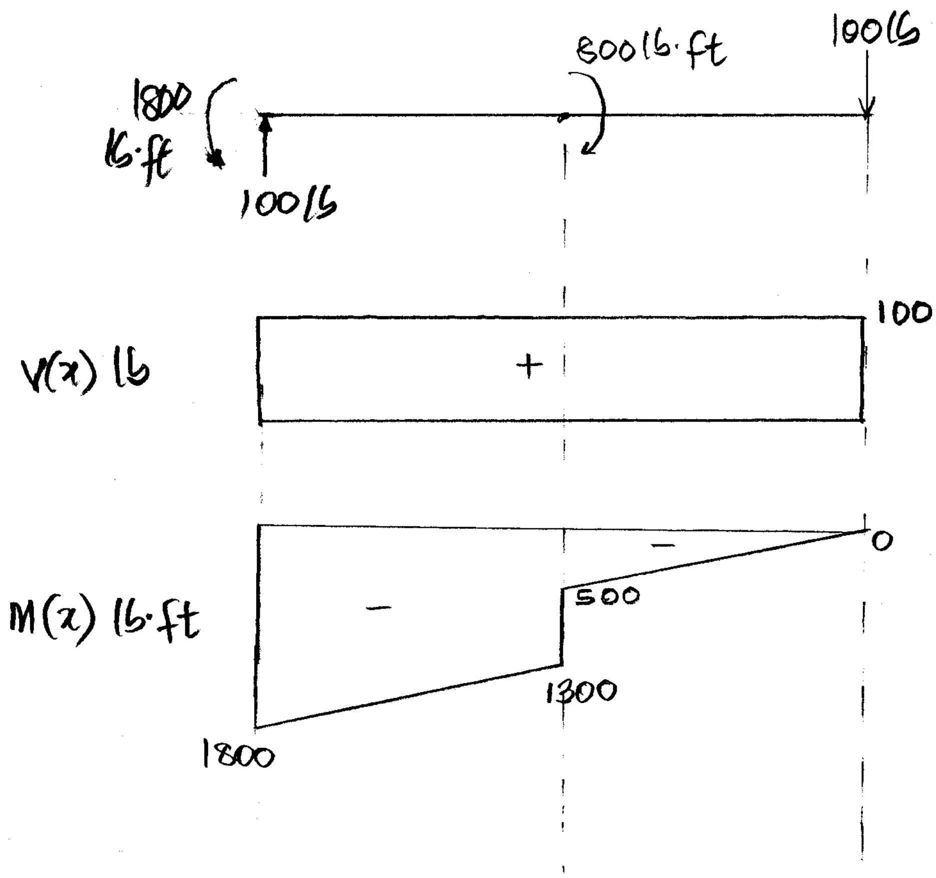
Shear force function, $V(x)$

$\Sigma F_y^{2-2} = 100 - V(x) = 0 \Rightarrow V(x) = 100, \quad 0' \le x \le 10'$

$\Sigma M^{1-1} = 1800 - 100x + M(x) = 0 \Rightarrow M(x) = 100x - 1800, \quad 0 \le x \le 5'$

$\Sigma M^{2-2} = 1800 - 100x - 800 + M(x) = 0 \Rightarrow M(x) = 100x - 1000, \quad 5' \le x \le 10'$

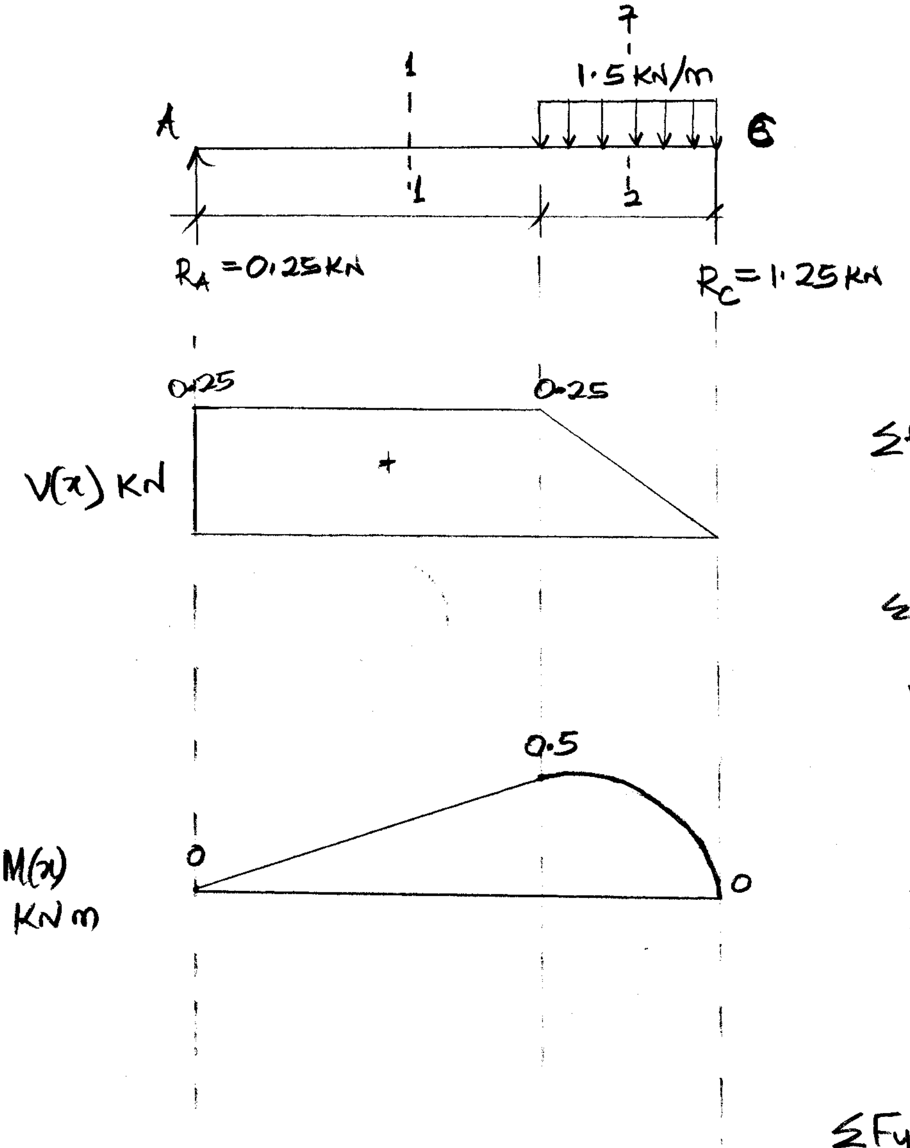
We can sketch these functions:

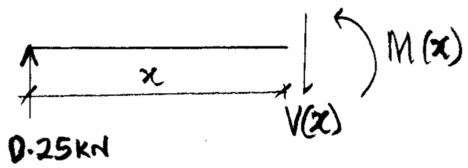


#6

$$\Sigma M_C = -3R_A + 1.5(0.5) = 0 \Rightarrow R_A = 0.25\text{ kN}$$

$$\Sigma F_y = 0.25 - 1.5 + R_C = 0 \Rightarrow R_C = 1.25\text{ kN}$$





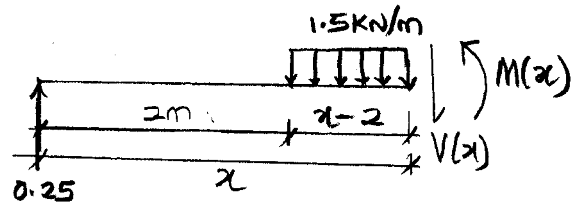
Section 1-1

$$\Sigma F_y = 0.25 - V(x) = 0$$

$$V(x) = 0.25 \quad ; \; 0 \le x \le 2\text{m}$$

$$\Sigma M^{1-1} = -0.25x + M(x) = 0$$

$$M(x) = 0.25x \quad ; \; 0 \le x \le 2\text{m}$$



Section 2-2

$$\Sigma F_y = 0.25 - 1.5(x-2) - V(x) = 0$$

$$V(x) = 3.25 - 1.5x, \quad 2 \le x \le 3\text{m}$$

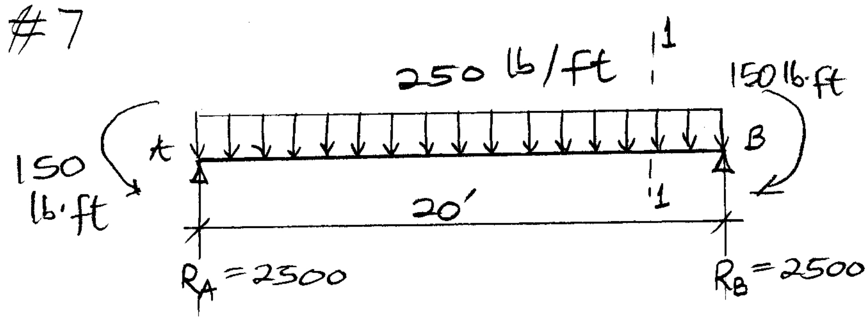
$$\Sigma M^{2-2} = -0.25x + 1.5(x-2)^2 \cdot \tfrac{1}{2} + M(x) = 0$$

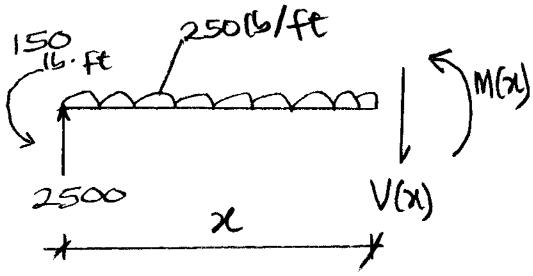
$$-0.25x + 0.75(x^2 - 2x + 4) + M(x) = 0$$

$$M(x) = -0.75x^2 + 1.75x - 3 \; ;$$

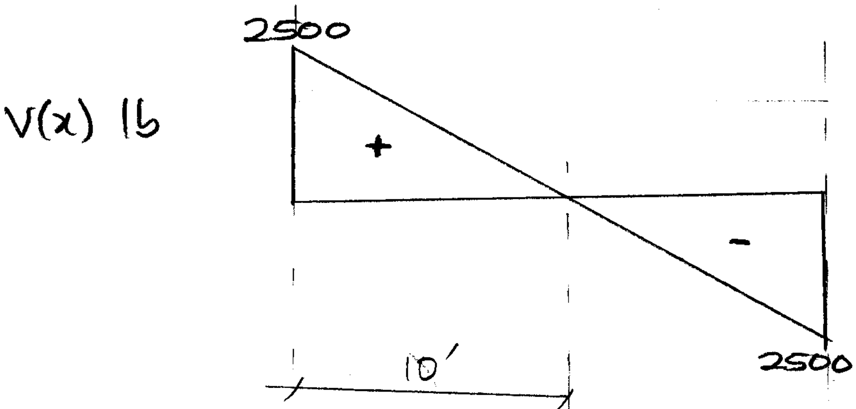
$$2 \le x \le 3\text{m}$$

#7





Section 1-1



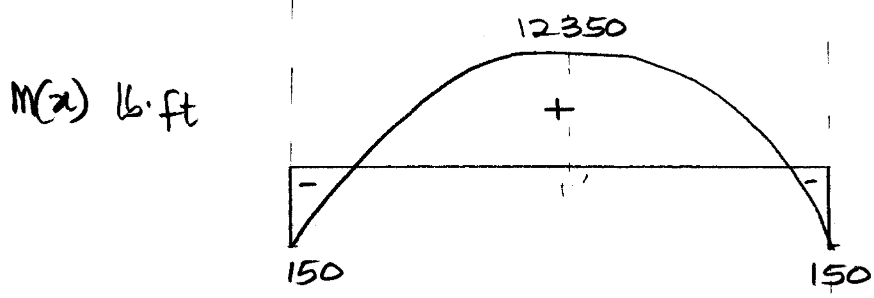
$$\Sigma M_B = 150 - 20R_A + 250(20)(10) - 150$$

$$5000 - 20R_A = 0$$

$$R_A = 2500 \text{ lb}$$

$$\Sigma F_y = 2500 - 250(20) + R_B = 0$$

$$R_B = 2500 \text{ lb}$$



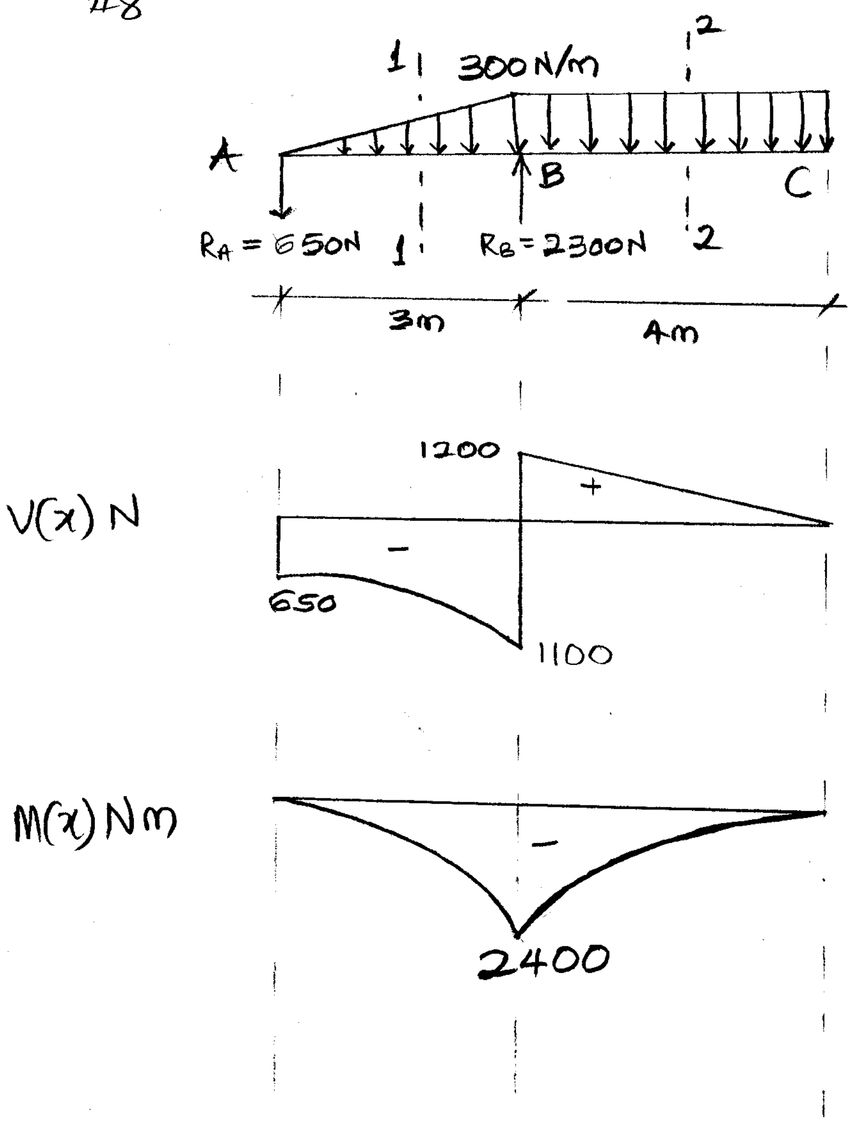
$$\Sigma F_y^{1-1} = 2500 - 250x - V(x) = 0$$

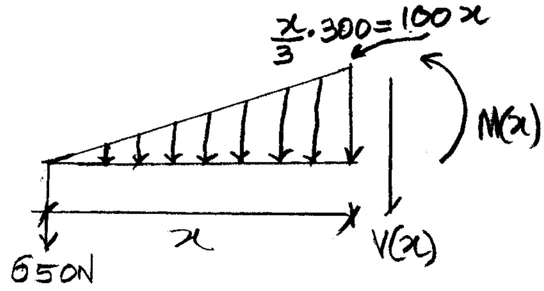
$$V(x) = 2500 - 250x \quad ; \quad 0 \le x \le 20'$$

$$\Sigma M^{1-1} = 150 - 2500x + 250x \cdot \frac{x}{2} + M(x) = 0$$

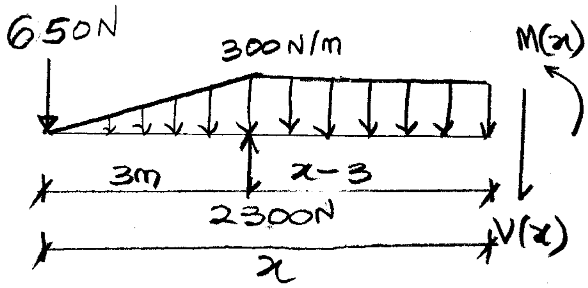
$$M(x) = -125x^2 + 2500x - 150 \quad ; \quad 0 \le x \le 20'$$

#8





Section 1-1



Section 2-2

$$\Sigma M_B = 3R_A + 0.5(300)(3)(1) - 300(4)(2) = 0$$

$$3R_A + 450 - 2400 = 0 \Rightarrow R_A = 650N$$

$$\Sigma F_y = -650 - 0.5(300)(3) - 300(4) + R_B = 0 \Rightarrow R_B = 2300\,N$$

At section 1-1,

$$V(x) = -650 - 50x^2 ; \quad 0 \leq x \leq 3m$$

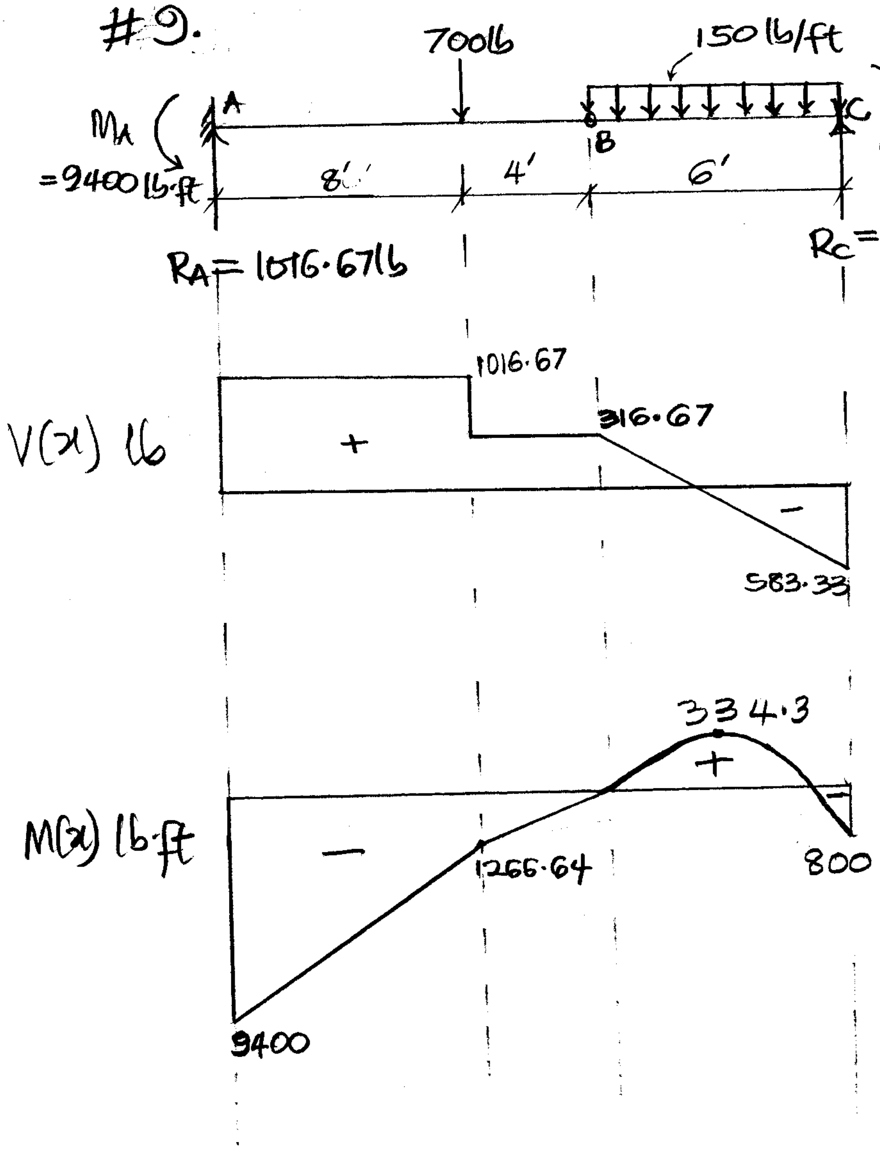
$$M(x) = -650x - \frac{50}{3}x^3 ; \quad 0 \leq x \leq 3m$$

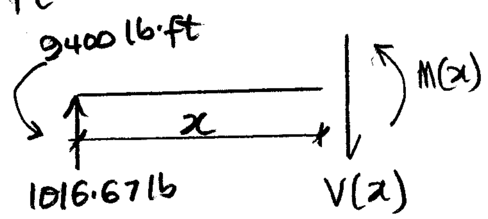
At section 2-2,

$$V(x) = 2100 - 300x ; \quad 3 \leq x \leq 7m$$

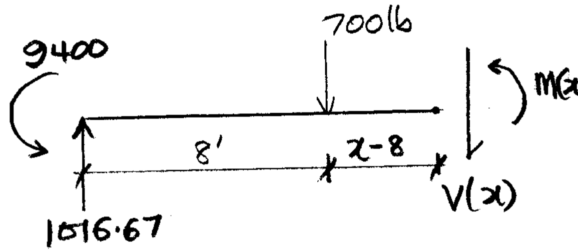
$$M(x) = -150x^2 + 2100x - 7350 ; \quad 3 \leq x \leq 7m$$

#9.

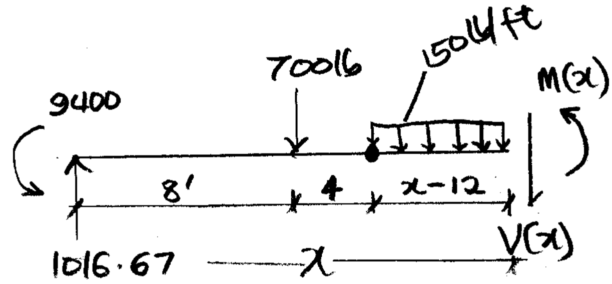




section 1-1



Section 2-2



Section 3-3

Reactions:

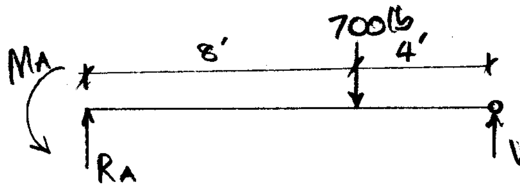
We can separate the structure into 2 parts at the hinge B. That will be easier, but we can as well proceed straight away!

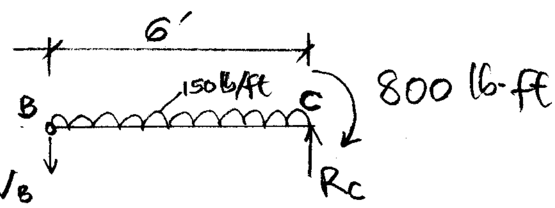
ΣM_B (right side of B) $= -800 + 6R_C - 150(6)(3) = 0 \Rightarrow \underline{R_C = 583.33 \text{ lb}}$

ΣF_y (right of B) $= -V_B - 150(6) + 583.33 = 0 \Rightarrow \underline{V_B = -316.67 \text{ lb}}$

ΣF_y (left side) $= R_A - 700 - 316.67 = 0 \Rightarrow \underline{R_A = 1016.67 \text{ lb}}$

ΣM_A (left side) $= M_A - 700(8) - 316.67(12) = 0 \Rightarrow \underline{M_A = 9400 \text{ lb·ft}}$





Shear force and bending moment functions:

Section 1-1 $(0 \leq x \leq 8')$

$\Sigma F_y^{1-1} = 1016.67 - V(x) = 0$

$V(x) = 1016.67 \quad ; \quad 0 \leq x \leq 8'$

$\Sigma M^{1-1} = 9400 - 1016.67x + M(x) = 0$

$M(x) = 1016.67x - 9400; \quad 0 \leq x \leq 8'$

Section 2-2 $(8' \leq x \leq 12')$

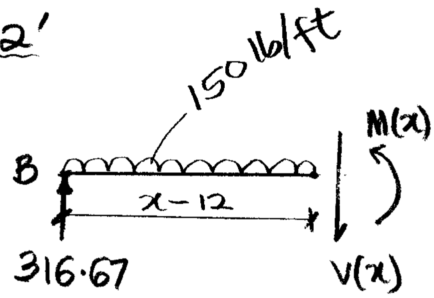
$\Sigma F_y^{2-2} = 1016.67 - 700 - V(x) = 0$

$V(x) = 316.67 \quad ; \quad 8' \leq x \leq 12'$

$\Sigma M^{2-2} = 9400 - 1016.67x + 700(x-8) + M(x) = 0$

$M(x) = 316.67x - 3800 \quad ; \quad 8' \leq x \leq 12'$

Section 3-3 $(12' \leq x \leq 18')$



Better picture of Section 3-3

$\Sigma F_y^{3-3} = 1016.67 - 700 - 150(x-12) - V(x) = 0$

$V(x) = 2116.67 - 150x; \quad 12' \leq x \leq 18'$

$\Sigma M^{3-3} = 150(x-12) \cdot (x-12)/2 - 316.67(x-12) + M(x) = 0$

$M(x) = -75x^2 + 2116.67x - 14600 \; ; \; 12' \leq x \leq 18'$