AEM 2011 EXAM 2

1. $h(x,y) = (0.2y + 0.5)\,m$

$0 \le x \le 4\,m$ and $0 \le y \le 5\,m$

$\rho = 300\ kg/m^3$

Volume $= V = \iint_A h(x,y)\,dx\,dy$

$$= \int_0^4 \int_0^5 (0.2y + 0.5)\,dy\,dx$$

$$= \int_0^4 5\,dx = 20$$

$m = \rho V = 300 \times 20 = 6000\ kg$

$W = mg = 58.86\ kN$

(a) $\boxed{\bar{W} = -58.86\ kN\ \hat{j}}$

(b) $V\bar{x} = \iint_A x\,h(x,y)\,dx\,dy$

$$= \int_0^4 \int_0^5 (0.5x + 0.2xy)\,dy\,dx$$

$$= \int_0^4 \left[(0.5x)y \Big|_0^5 + 0.2x \frac{y^2}{2} \Big|_0^5 \right] dx$$

$$= \int_0^4 \left[(0.5x)\,5 + (0.1x)\,25 \right] dx$$

(2)

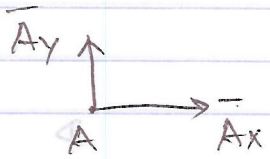
$$20\,\bar{x} = \int_0^4 5x\,dx = 5\,\frac{x^2}{2}\Big|_0^4 = 40$$

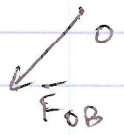
$$\boxed{\bar{x} = 2\ m}$$

2. $W = 30\,KN$

Assume OB is in tension

$$\hat{OB} = \frac{\overline{OB}}{|\overline{OB}|} = \frac{(5,20)}{5\sqrt{17}} = \left(\frac{1}{\sqrt{17}}, \frac{4}{\sqrt{17}}\right)$$





$$\bar{F}_A = (A_x, A_y)$$

$$\bar{F}_{OB} = -F_{OB}\,\hat{OB} = -F_{OB}\left(\frac{1}{\sqrt{17}}, \frac{4}{\sqrt{17}}\right)$$

$$\Sigma F_x: \quad A_x - \frac{F_{OB}}{\sqrt{17}} = 0$$

$$\Sigma F_y: \quad A_y - F_{OB}\cdot\frac{4}{\sqrt{17}} - 30e3 = 0$$

$$\Sigma M_A: \quad -\frac{F_{OB}}{\sqrt{17}}(10) - 30e3\,(25) = 0$$

$$F_{OB}\,\frac{10}{\sqrt{17}} = -0.75e6$$

$$F_{OB} = -309.23\,KN$$

$$A_x = -75\,KN$$

$$A_y = -270\,KN$$

(4)

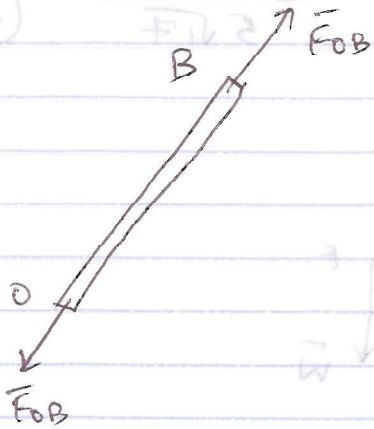
(a)

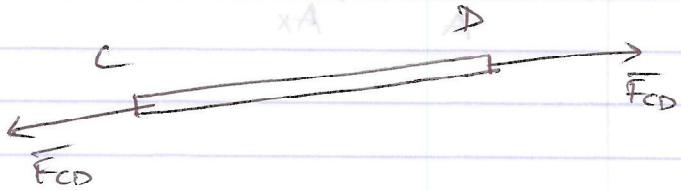
$\bar{A}_x = 75\ kN \leftarrow$

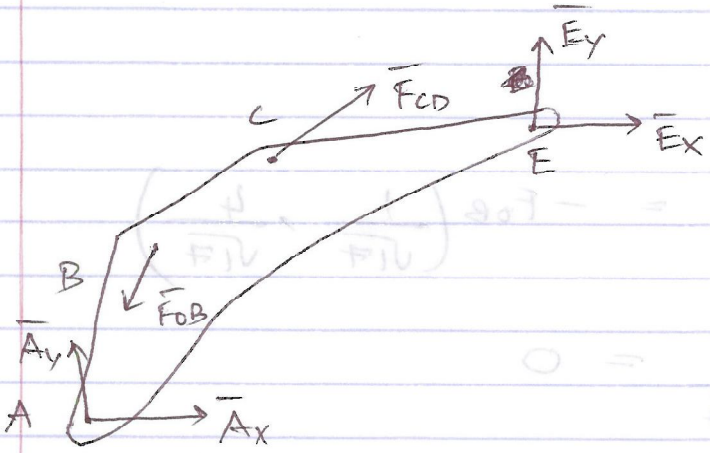
$\bar{A}_y = 270\ kN \downarrow$

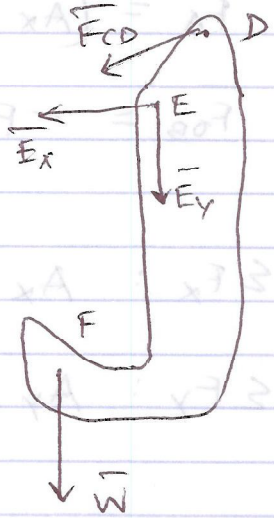
$F_{OB} = 309.23\ kN$ (compression)

(b)









(c) Consider member ABCE. We already solved for A_x, A_y, and F_{OB}. There are three unknowns: F_{CD}, E_x, and E_y. Note that since CD is a two-force member, the direction of $\bar{F}_{CD}$ is already known. — only its magnitude is unknown. Alternatively, member DEF may be considered. The 3 unknowns can be solved for from 3 equations.

Problem – 3

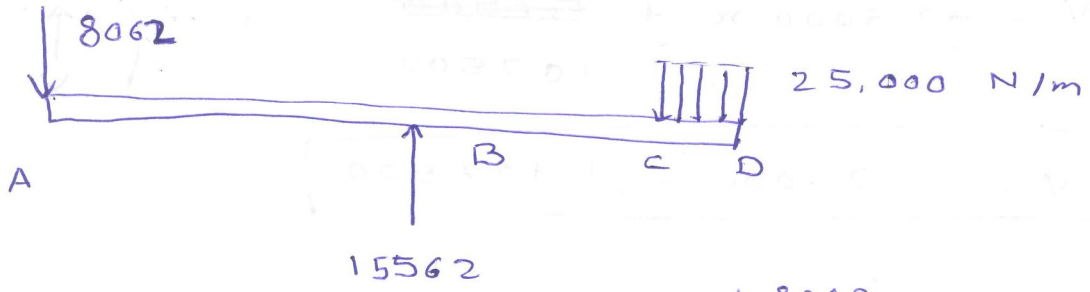
a) $W = 7500\ N$

Weight density $= \frac{W}{0.3m}$

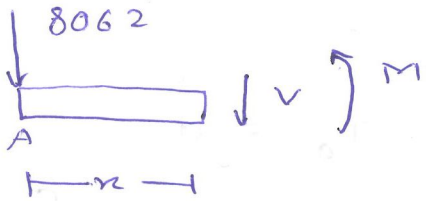
$\Rightarrow w(x) = \frac{7500}{0.3} = 25000\ N/m$

$= 25\ kN/m$

b) FBD



→ For AB



$\Sigma F_y = 0$

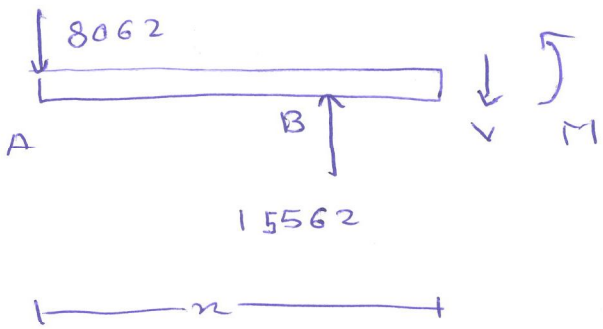
$\Rightarrow \boxed{V = -8062\ N}$

$\Sigma M_A = 0$

$\Rightarrow -Vx + M = 0$

$\Rightarrow \boxed{M = -8062x\ Nm}$

→ For BC



$\Sigma F_y = 0$

$\Rightarrow V = 15562 - 8062$

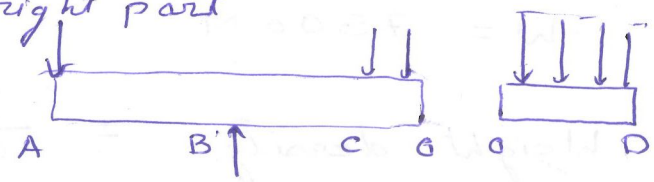
$\Rightarrow \boxed{V = 7500\ N}$

$\Sigma M_A = 0$

$\Rightarrow \boxed{M = 7500x - 31124}$

→ For CD

We will consider the right part



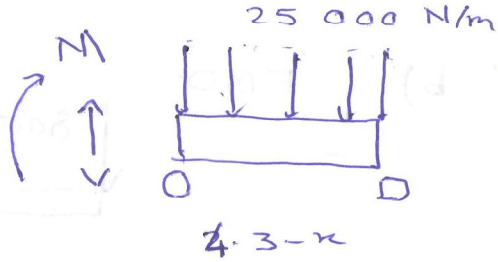
$\Sigma F_y = 0$

$\Rightarrow \quad V - 25000 \times (4.3 - x) = 0$

$\Rightarrow \quad V = -25000\,x + 107500$

$\Rightarrow \boxed{V = -25000\,x + 107500}$

$\equiv$



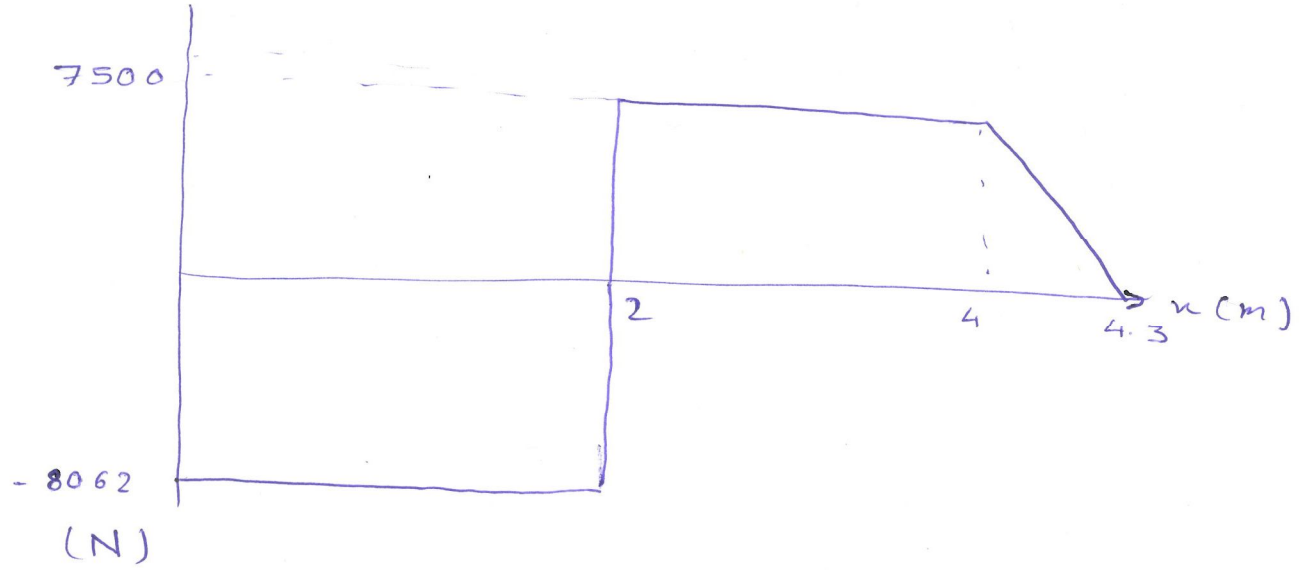
$\Sigma M_O = 0$

$\Rightarrow \quad -M - \left[25000 \times (4.3 - x)\right] \times \frac{(4.3 - x)}{2} = 0$

$\Rightarrow \boxed{M = -12500\,x^2 + 107500\,x - 231125 \text{ Nm}}$

Plotting these, we get

V =



M =