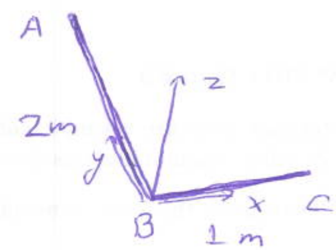
Mid - term - 2

Q1) $\rho = 1\ kg/m$

(a) Dividing the wire into 2 parts AB, BC



→ For AB

$m_1 = \rho \times L = 1 \times 2 = 2\ kg$

$\bar{X}_1 = 0$

$\bar{Y}_1 = 1\ m$

→ For BC

$m_2 = \rho \times L = 1 \times 1 = 1\ kg$

$\bar{X}_2 = 0.5\ m$

$\bar{Y}_2 = 0\ m$

For the entire body

$$\bar{X} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{(2 \times 0) + (1 \times 0.5)}{2 + 1}$$

$$= \frac{1}{6}\ m$$

$$\bar{Y} = \frac{m_1 Y_1 + m_2 Y_2}{m_1 + m_2} = \frac{(2 \times 1) + (1 \times 0)}{2 + 1}$$

$$= \frac{2}{3}\ m$$

$\Rightarrow$ Centroid $= \left(\frac{1}{6}, \frac{2}{3} \right)$

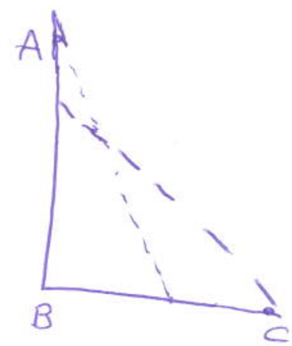
(b) No,

For equilibrium, our finger should be on the centroid of the wire. But as the wire does not pass through the CG, there is no point on the wire, where it can be supported.

(c) Any two points are OK, if the two points are colinear ~~about~~ with the CG.

One such pair on AB : $(0, \frac{5}{6})$, on BC: $(0, \frac{5}{6})$

(d) We can see that for small y_0 there does not exist a place on BC so that the ~~wire~~ wire is in equilibrium



Min y_0 is just where the other finger is at C

condition of colinearity

$$\frac{y_0 - \frac{2}{3}}{0 - \frac{1}{6}} = \frac{y_0 - 0}{0 - 1}$$

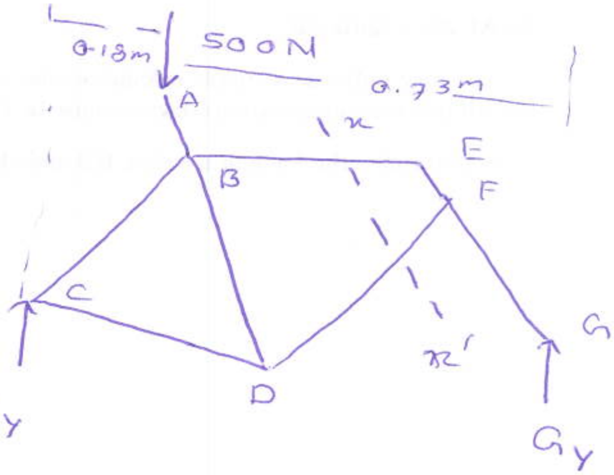
(AG, AC have same slope

$\Rightarrow \quad y_0 - \frac{2}{3} = \frac{1}{6} y_0$

$\rightarrow \quad y_0 = \cancel{\frac{5}{6}} / \cancel{\frac{2}{3}} \quad \frac{6}{5} \times \frac{2}{3} = 0.8$

$\Rightarrow \quad \boxed{y_0 < 0.8}$

(e) No, center of gravity won't change as the mass distribution remains the same.



Q - 2 a) Considering entire structure

$\Sigma F_y = 0$

$\Rightarrow C_y + G_y = 500$

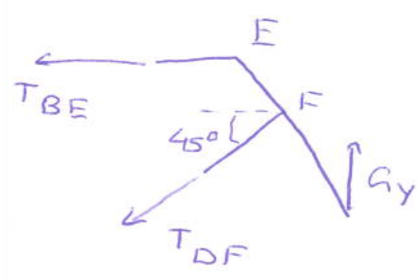
$\Sigma M_C = 0$

$\Rightarrow 0.91\ G_y = 500 \times 0.18$

$\Rightarrow \boxed{G_y = 98.9\text{ N}}$

$\Rightarrow \boxed{C_y = 401.1\text{ N}}$

(b) Considering the right part of section xx'



$\Sigma F_y = 0$

$\Rightarrow G_y - T_{DF} \times \frac{1}{\sqrt{2}} = 0$

$\Rightarrow \boxed{T_{DF} = 139.86\text{ N}}$ (Tension)

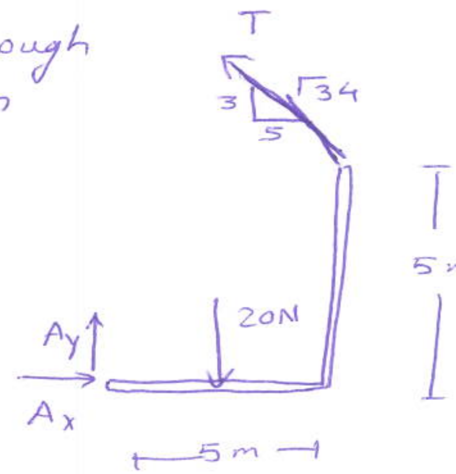
$\Sigma F_x = 0$

$\Rightarrow -T_{DF} \times \frac{1}{\sqrt{2}} - T_{BE} = 0$

$\Rightarrow \boxed{T_{BE} = -98.9\text{ N}}$ 98.9 N in compression

(c) It will increase.
As C is moved towards Left, the force G_y increases, so force in DF also increases

Q - 3 a) We can replace the distributed load as a single force, through the centroid of the distribution (mid point of AB)



$$F = \int_0^5 W(x)\,dx$$

$$= 4 \times 5 = 20\,N$$

For equilibrium

$\rightarrow M_A = 0$

$$\Rightarrow T \times \frac{3}{\sqrt{34}} \times 5 + T \times \frac{5}{\sqrt{34}} \times 5 - 20 \times \frac{5}{2} = 0$$

$$\Rightarrow T\left(\frac{40}{\sqrt{34}}\right) - \frac{100}{2} = 0$$

$$\Rightarrow \boxed{T = \frac{50 \times \sqrt{34}}{40} = 7.29\,N}$$

$\rightarrow \Sigma F_x = 0$

$$\Rightarrow A_x - T \times \frac{5}{\sqrt{34}} = 0$$

$$\Rightarrow \boxed{A_x = 6.25\,N}$$

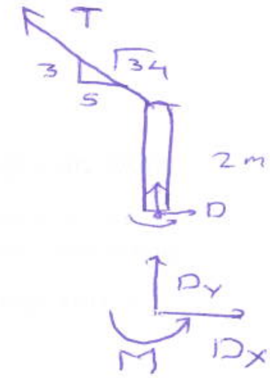
$\rightarrow \Sigma F_y = 0$

$$\Rightarrow A_y + T \times \frac{3}{\sqrt{34}} - 20 = 0$$

$$\Rightarrow \cancel{A_y = -3.75\,N}$$

$$\boxed{A_y = 16.25\,N}$$

(b) Considering the upper part at D (by lower part)



For equilibrium

$\rightarrow \quad \Sigma F_X = 0$

$\Rightarrow \quad D_X - T \times \frac{5}{\sqrt{34}} = 0$

$\Rightarrow \quad \boxed{D_X = 6.25 \text{ N}}$

$\rightarrow \quad \Sigma F_Y = 0$

$\Rightarrow \quad D_Y + T \times \frac{3}{\sqrt{34}} = 0$

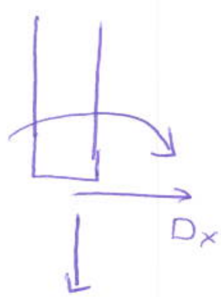
$\Rightarrow \quad \boxed{D_Y = -3.75 \text{ N}}$

$\rightarrow \quad \Sigma M_D = 0$

$\Rightarrow \quad T \times \frac{5}{\sqrt{34}} \times 2 + M = 0$

$\Rightarrow \quad \boxed{M = -12.5 \text{ N-m}}$

$\Rightarrow$ Forces and moments by the lower part, on the upper part



Axial force = 3.75 N in tension

Shear force = 6.25 N toward right

Moment = 12.5 N-m clockwise

(c) Same, as there is no other force in axial direction between C and F

d) Smaller, as the moment that the internal moment has to counter (due to T) is less about E than at D, moment will decrease.