Atividade Continuada 03

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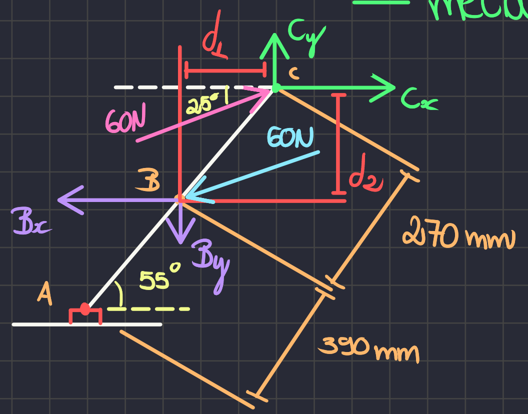
— mecânica geral —

1)



$$\cos 55° = \frac{d_1}{270 \cdot 10^{-3}} \rightarrow d_1 = 0{,}1549\,m$$

$$\text{sen } 55° = \frac{d_2}{270 \cdot 10^{-3}} \rightarrow d_2 = 0{,}2212\,m$$

a) Como a força $\vec{B}$ está no ponto B, ela não entra no cálculo do momento, portanto:

$$M_B = M = C_y d_1 - C_x d_2$$

↳ encontrando as componentes de C:

$$C_x = \cos 25° \cdot 60 \rightarrow C_x = 54{,}3785\ N$$

$$C_y = \text{sen } 25° \cdot 60 \rightarrow C_y = 25{,}3571\ N$$

$$\therefore \quad M = 25{,}3571 \cdot 0{,}1549\ \hat{z} - 54{,}3784 \cdot 0{,}2212\ \hat{z} \rightarrow$$

$$M = 3{,}9278\ \hat{z} - 12{,}0285\ \hat{z} \rightarrow$$

$$M = -8{,}1\ [N \cdot m]\ \hat{z}$$

b) usando a distância entre as duas forças

$$d = 0{,}270 \cdot \text{sen}(55° - 25°) \rightarrow d = 0{,}135\,m$$

$$M = Fd \cdot (-\hat{z}) \rightarrow$$

$$M = 60 \cdot 0{,}135\ (-\hat{z}) \rightarrow M = -8{,}1\ [N \cdot m]\ \hat{z}$$

c) somando em relação ao eixo A :

$$M_A = d_{BA} \times F_B + d_{CA} \times F_C \rightarrow$$

$$M_A = (0{,}390)(60)\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \cos 55° & \operatorname{sen} 55° & 0 \\ -\cos 25° & -\operatorname{sen} 25° & 0 \end{vmatrix} + (0{,}660)(60)\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \cos 55° & \operatorname{sen} 55° & 0 \\ \cos 25° & \operatorname{sen} 25° & 0 \end{vmatrix} \rightarrow$$

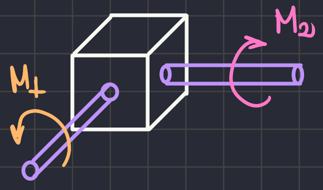
$$M_A = (23{,}4)\left(-\cos 55° \cdot \operatorname{sen} 25° \hat{k} + \cos 25° \operatorname{sen} 55° \hat{k}\right)$$

$$+ (39{,}6)\left(\cos 55° \operatorname{sen} 25° \hat{k} - \cos 25° \cdot \operatorname{sen} 55° \hat{k}\right) \rightarrow$$

$$M_A = (23{,}4)(0{,}5\hat{k}) + (39{,}6)(-0{,}5\hat{k}) \rightarrow$$

$$M_A = 11{,}7\hat{k} - 19{,}8\hat{k} \rightarrow M_A = -8{,}1\,[N \cdot m]\,\hat{k}$$

2)



$M_1 = 11 \; N\cdot m \; \hat{z}$

$M_2 = 8 \; N\cdot m \; \hat{x}$

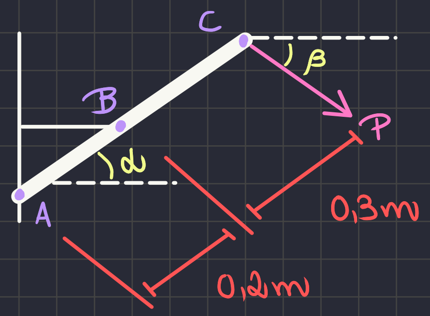
$$\vec{M}_{12} = 8\hat{x} + 11\hat{z} \Rightarrow |\vec{M}_{12}| = \sqrt{8^2 + 11^2} = 13{,}6015 \; N\cdot m$$

$$\cos\theta_x = \frac{M_{12x}}{|M_{12}|} = \frac{8}{13{,}6015} \rightarrow \theta_x = \cos^{-1}(0{,}5882) = 53{,}97^\circ$$

$$\cos\theta_y = \frac{M_{12y}}{|M_{12}|} = 0 \rightarrow \theta_y = \cos^{-1}(0) = 90^\circ$$

$$\cos\theta_z = \frac{M_{12z}}{|M_{12}|} = \frac{11}{13{,}6015} \rightarrow \theta_z = \cos^{-1}(0{,}8087) = 36{,}03^\circ$$

3)



$P = 300N$

$\alpha = 60°$

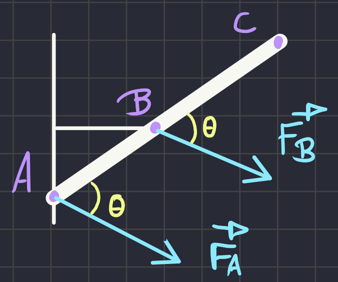
$\beta = 30°$

a) calculando o equivalente em B:

$F_B = P \rightarrow F_B = 300\ N$

$M_B = -F \cdot d \rightarrow M_B = -(0{,}3)(300) = -90\ N \cdot m$

b) somando as parciais relativas a cada eixo para encontrar o momento, nos pontos A e B:



- em x, como $\theta = 30 + 60 = 90°$:

$F_A \cdot \cos\theta = -F_B \cdot \cos\theta \rightarrow$

$F_A \cdot \cos\theta + F_B \cos\theta = 0$

$\therefore\ F_A = -F_B$ OU $\cos\theta = 0$

- em y, como as duas apontam p/ baixo:

$-F_A \operatorname{sen}\theta - F_B \operatorname{sen}\theta = -300 \rightarrow$

• considerando $F_A = -F_B$:

$-\cancel{F_A \operatorname{sen}\theta} + \cancel{F_A \operatorname{sen}\theta} = -300 \rightarrow 0 = -300$ ✗

• então $\cos\theta = 0$:

$-F_A - F_B = -300 \rightarrow F_A + F_B = 300$

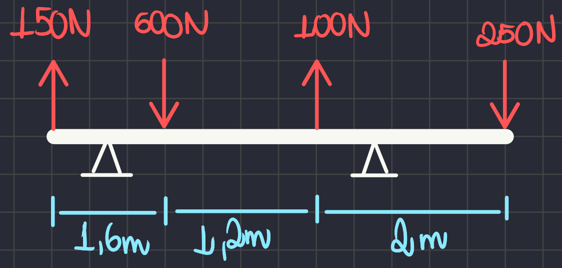
↯ encontrando a equivalente do C:

$M_B = F_A \cdot d_{AB} \rightarrow -90 = 0{,}2 F_A \rightarrow F_A = -450\ N$

$F_A + F_B = 300 \rightarrow -450 + F_B = 300 \rightarrow$

$F_B = -750\ N$

4)



a) calculando a força resultante ($\vec{F}_R$) e o momento resultante:

$$F_R = 150\,\hat{y} - 600\,\hat{y} + 100\,\hat{y} - 250\,\hat{y} \Rightarrow$$

$$F_R = -600\,\hat{y}\ N$$

$$M_A = 1{,}6 \cdot (-600) + 2{,}8 \cdot (100) + 4{,}8\,(-250) \Rightarrow$$

$$M_A = -1880\ N \cdot m\ \hat{z} \Rightarrow M_A = 1880\ N \cdot m \circlearrowright$$

b) com a mesma força $\vec{F}_R$ mas o equivalente em B:

$$M_B = 2(100) + 3{,}2(-600) + 4{,}8(150) \Rightarrow$$

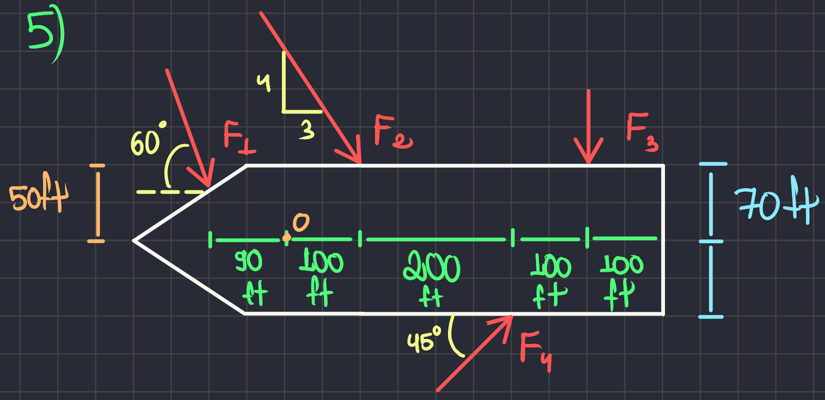
$$M_B = -1000\ N \cdot m \Rightarrow M_B = 1000\ N \cdot m\ \hat{z} \circlearrowleft$$

c) encontrando a posição do vetor resultante:

$$r \times R = M_A \Rightarrow x\,\hat{i} \times (-600)\,\hat{j} = -1880\,\hat{k} \Rightarrow$$

$$-600x\,\cancel{\hat{k}} = -1880\,\cancel{\hat{k}} \Rightarrow x = 3{,}13m$$

5)



a) convertendo as forças em x e y:

$$F_1 = +(F_1 \cos 60°)\,\hat{x} - (F_1 \operatorname{sen} 60°)\,\hat{y} = +2{,}5k\,\hat{x} - 4{,}33\,k\,\hat{y}\ [lb]$$

$$F_2 = (F_2 \cos 53{,}13°)\,\hat{x} - (F_2 \operatorname{sen} 53{,}13°)\,y = 3k\,\hat{x} - 4k\,\hat{y}\ [lb]$$

$$F_3 = -5k\,\hat{y}\ [lb]$$

$$F_4 = (F_4 \cos 45°)\,\hat{x} + (F_4 \cos 45°)\,\hat{y} = 3{,}535k\,\hat{x} + 3{,}535\,k\,\hat{x}\ [lb]$$

- encontrando a resultante e o momento:

$$F_R = 9{,}035k\,\hat{x} - 9{,}795k\,\hat{y}\ [lb]$$

$$M_o = (-90\,\hat{x} + 50\,\hat{y}) \times (2{,}5\,\hat{x} - 4{,}33\,\hat{y}) + (100\,\hat{x} + 70\,\hat{y}) \times (3\,\hat{x} - 4\,\hat{j}) + (400\,\hat{i} + 70\,\hat{j}) \times (-5\,\hat{j}) + (300\,\hat{x} - 70\,\hat{y}) \times (3{,}54\,\hat{x} + 3{,}54\,\hat{j} \rightarrow$$

$$M_o = (390 - 125 - 400 - 210 - 2000 + 1062 + 248)\,\hat{y} \rightarrow$$

$$M_o = -1035\,\hat{j}$$

$$\theta = tg^{-1}\,\frac{9{,}795}{9{,}035} \rightarrow$$

$$F_R = \sqrt{9{,}035k^2 + 9{,}795k^2} = 13{,}325k\ lb$$

$$\theta = 47{,}31°$$

b) como a força deve ser igual a F_R e o ponto de aplicação igual a M_o:

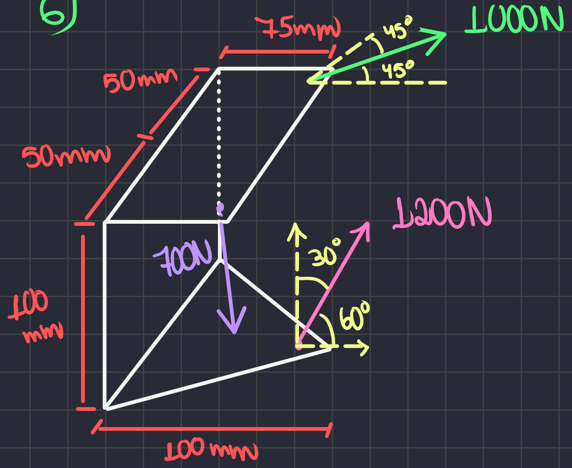
$$\Rightarrow\ r = x\hat{i} + 70\hat{j}$$

$$r \times F_R = M_o \rightarrow (x\hat{i} + 70\hat{j}) \times (9{,}04\hat{i} - 9{,}79\hat{j}) = -1035\hat{k} \rightarrow$$

$$-9{,}79x\,\hat{k} - 633\hat{k} = -1035\hat{k} \rightarrow$$

$$x = 41{,}1ft$$

6)



• E (150mm, -50mm, 100mm)

- primeiramente encontrando os vetores do ponto A até o final:

$$\lambda_{BE} = \frac{\vec{BE}}{BE} = \frac{(150m, -50m, 100m) - (75m, 100m, 100m)}{175} \to$$

$$\lambda_{BE} = \frac{(75m, -150m, 50m)}{175}$$

$$\vec{r}_{B/A} = \overline{AB} = 0{,}075\hat{x} + 0{,}050\hat{y} \qquad \vec{F_B} = 300\hat{x} - 600\hat{y} + 200\hat{z}$$

$$\vec{r}_{C/A} = \overline{AC} = 0{,}075\hat{x} - 0{,}050\hat{y} \qquad \vec{F_c} = 707\hat{x} - 707\hat{z}$$

$$\vec{r}_{D/A} = \overline{AD} = 0{,}1\hat{x} - 0{,}1\hat{y} \qquad \vec{F_D} = 600\hat{x} + 1039\hat{y}$$

$$\vec{r}_{B/A} \times F_B = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 0{,}075 & 0 & 0{,}050 \\ 300 & -600 & 200 \end{vmatrix} = (15\hat{y} - 45\hat{z}) - (-30\hat{x} + 15y) \to = 30\hat{x} - 45\hat{z}$$

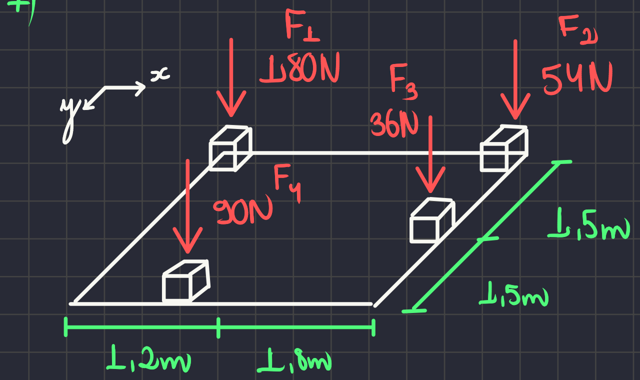
$$\vec{r}_{C/A} \times F_C = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 0{,}075 & 0 & -0{,}050 \\ 707 & 0 & -707 \end{vmatrix} = (-35{,}35\hat{y}) - (-53{,}025\hat{y}) = 17{,}675\hat{y}$$

$$\vec{r}_{D/A} \times F_D = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 0{,}1 & -0{,}1 & 0 \\ 600 & 1039 & 0 \end{vmatrix} = (103{,}9\hat{z}) - (-60\hat{z}) \to = 163{,}9\hat{z}$$

- agora encontrando M_A:

$$M_A = \Sigma_i (\vec{r} \times \vec{F}) = (30\ N\cdot m)\hat{x} + (17{,}68\ N\cdot m)\hat{y} + (118{,}9\ N\cdot m)\hat{z}$$

7)



$$\begin{cases} \vec{r_1} = 0 \\ \vec{r_2} = 3\hat{x} \\ \vec{r_3} = (3\hat{x} + 1{,}5\hat{y}) \\ \vec{r_4} = (1{,}2\hat{x} + 3\hat{y}) \end{cases}$$

- Calculando os momentos relativos a origem:

$M_O^1 = 0 \Rightarrow$ Está na origem!

$M_O^2 = r_2 \times F_2 = -162\hat{y}$ [N·m]

$M_O^3 = r_3 \times F_3 = 54\hat{x} - 108\hat{y}$ [N·m]

$M_O^4 = r_4 \times F_4 = 270\hat{x} - 108\hat{y}$ [N·m]

$M_O^5 = r_5 \times F_5 = 324\hat{x} - 378\hat{y}$ [N·m]

- Encontrando as resultantes:

$\vec{R} = (-360\hat{y})$ N $\qquad M_O^R = 324\hat{x} - 378\hat{y}$ [N·m]

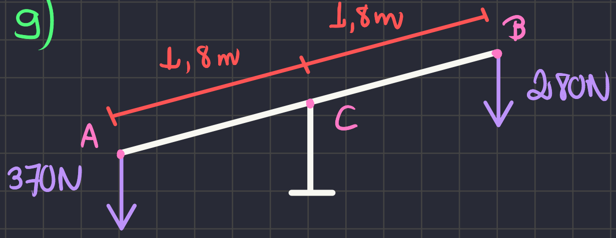
$\vec{r} \times \vec{R} = M_O^R \Rightarrow (x\hat{i} + y\hat{y}) \times (-360\hat{y}) = (324\hat{x} - 378\hat{y}) \Rightarrow$

$(-360x)\hat{y} + (360y)\hat{x} = 324\hat{x} - 378\hat{y} \Rightarrow$

$\Rightarrow x = 1{,}05$m $\qquad y = 0{,}9$m

$R = -360\hat{y}$ [N] e $\theta = tg^{-1}\frac{y}{x} = 40{,}60°$

9)



a) p/ 260 N

$370 \cdot 1{,}8 - 260 \cdot d - 280 \cdot 1{,}8 = 0 \Rightarrow 162 = 260\,d \Rightarrow$

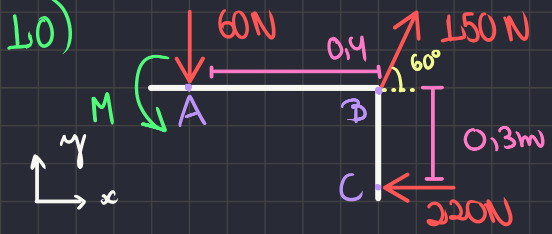
$d = 0{,}6231\,m$

b) p/ 230 N

$370 \cdot 1{,}8 - 230d - 280 \cdot 1{,}8 = 0 \Rightarrow 162 = 230\,d \Rightarrow$

$d = 0{,}7043\,m$

10)



$M = 8\ N \cdot m$

a) - somando as forças para encontrar $\vec{F_R}$

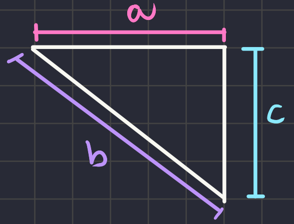
$$\vec{F_R} = \vec{R} = (-60\hat{y}) + (150\cos 60^\circ \hat{x} + 150 \sin 60^\circ \hat{y}) + (-220\hat{x})$$

$$= (-145)\hat{x} + (69,9038)\hat{y}$$

$$\lightning \quad R = 160,9706\ N$$

$$\theta = tg^{-1} \frac{69,9038}{145} = 25,74^\circ$$

b) - reduzindo as forças para o ponto B, com R e M_B:



$$M_B = 8\hat{z} + [-0,4\hat{x} \times (-60\hat{j})] + [(-0,3\hat{j}) \times (-220\hat{i})] \rightarrow$$

$$M_B = 8\hat{z} + 24\hat{z} - 66\hat{z} = -34\hat{z}\ [N \cdot m]$$

- agora com R em D:

$$M_B = d_{DB} \times R \rightarrow M_B = -a\hat{x} \times (-145\hat{x} + 69,9039\hat{y}) \rightarrow$$

$$-34\hat{z} = -(69,903a)\hat{z} \rightarrow a = 0,4863\hat{z}\ [m] = 0,4863\ m$$

- agora com R em E:

$$M_B = d_{EB} \times R \rightarrow M_B = -c\hat{y} \times (-145\hat{x} \times 69,9039\hat{y}) \rightarrow$$

$$-34\hat{z} = -145 \cdot c\,\hat{z} \rightarrow c = 0,2345\hat{z}\ [m] = 0,2345\ m$$

ii) $\Sigma M_R = 0$

- calculando primeiro no ponto A:

$$M_A = M + M_A^B + M_A^C = M + (0{,}4\hat{x} \times 150 \operatorname{sen}60°\hat{j}) + [-0{,}300\hat{j} \times (-220\hat{x})] \Rightarrow$$

$$0 = M + 51{,}9615\hat{y} - 66\hat{y} \Rightarrow M = 14{,}0385\ N\cdot m$$

- agora no ponto B:

$$M_B = M + M_B^A + M_B^C = M + [-0{,}400\hat{x} \times (-60\hat{y})] + [-0{,}3\hat{y} \times (-220\hat{x})] \Rightarrow$$

$$0 = M + 24\hat{y} - 66\hat{y} \Rightarrow M = 42\ N\cdot m$$

- por fim no ponto C:

$$M_C = M + M_C^A + M_C^B = M + [-0{,}4\hat{x} \times (-60\hat{y})] + [-0{,}3\hat{j} \times (150\cos 60\hat{x})] \Rightarrow$$

$$0 = M + 24\hat{y} - 22{,}5\hat{y} \Rightarrow M = -1{,}5\ [N\cdot m]$$