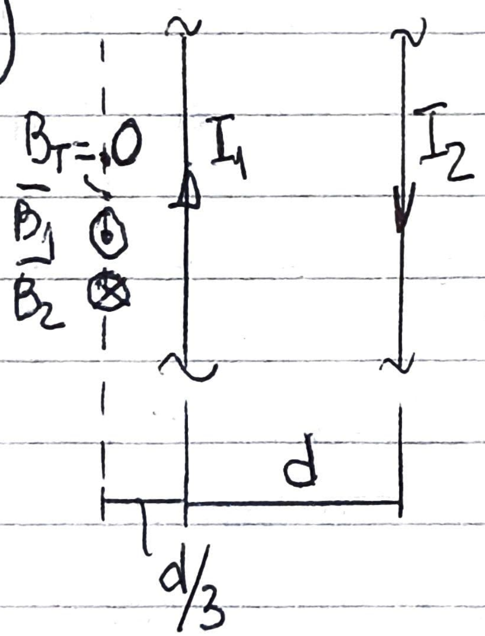
13)

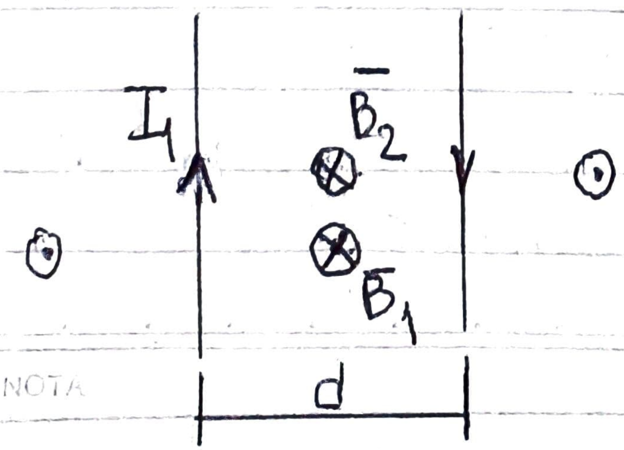


a) Sentidos: fijamos el sentido de I_1 y luego deducimos el de I_2 para que el campo total en la zona indicada sea nulo $\Rightarrow I_1, I_2$ antiparalelos

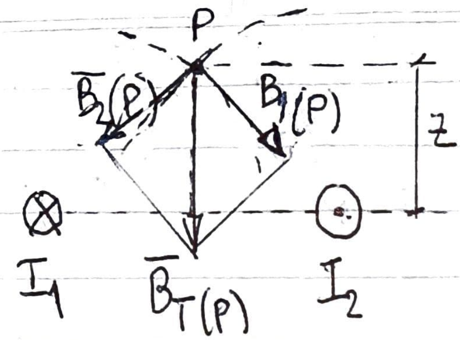
Para hallar la relación entre I_1 e I_2 igualamos los módulos de B_1 y B_2 en la región indicada ($B_1 = B_2$)

$$\frac{\cancel{\mu_0} I_1}{\cancel{2\pi} \frac{d}{3}} = \frac{\cancel{\mu_0} I_2}{\cancel{2\pi}\left(d + \frac{d}{3}\right)} \Rightarrow I_2 = 4 I_1$$

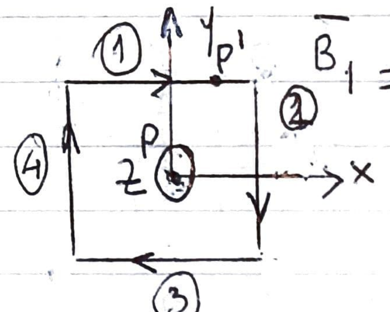
b) B_{TOTAL} en el punto medio entre los alambres:



$$B_T = B_1 + B_2 = \frac{\mu_0 I_1}{\cancel{2}\pi \frac{d}{\cancel{2}}} + \frac{\mu_0 I_2}{\cancel{2}\pi \frac{d}{\cancel{2}}} = \frac{\mu_0}{\pi d}(I_1 + I_2)$$



18)



$$\bar{B}_1 = \frac{\mu_0 I}{4\pi}\int_{AB} \frac{\bar{dr}' \times (\bar{r} - \bar{r}')}{|\bar{r} - \bar{r}'|^3} \quad ; \quad \bar{dr}' = dx\, \breve{e}_x$$

$P: \bar{r} = (0,0)$; $\bar{r}' = (x', \frac{L}{2})$ Corresp a Pto fuente (P')

$$\bar{r} - \bar{r}' = \left(-x', \frac{L}{2}\right)$$

$$|\bar{r} - \bar{r}'|^3 = \left[(-x')^2 + \left(\frac{L}{2}\right)^2\right]^{3/2}$$

$$\bar{dr}' \times (\bar{r} - \bar{r}') = \begin{vmatrix} \breve{e}_x & \breve{e}_y & \breve{e}_z \\ dx & 0 & 0 \\ -x' & \frac{L}{2} & 0 \end{vmatrix} = \left(0, 0, \frac{L}{2} dx'\right)$$

$$\bar{B}_1 = \frac{\mu_0 I}{4\pi} \int \frac{\left(0, 0, \frac{L}{2} dx'\right)}{\left[(x')^2 + \left(\frac{L}{2}\right)^2\right]^{3/2}} \rightarrow \frac{L}{2}\int_{-\frac{L}{2}}^{\frac{L}{2}} \frac{dx'}{\left[(x')^2 + \left(\frac{L}{2}\right)^2\right]^{3/2}} = \frac{L}{2}\left[\frac{x'}{\left(\frac{L}{2}\right)^2 \sqrt{(x')^2 + \left(\frac{L}{2}\right)^2}}\right]_{-\frac{L}{2}}^{\frac{L}{2}}$$

$$\frac{L}{2}\left(\frac{L/2}{\left(\frac{L}{2}\right)^2 \sqrt{2\frac{L^2}{4}}} - \frac{-L/2}{\left(\frac{L}{2}\right)^2 \sqrt{2\frac{L^2}{4}}}\right) = \frac{\cancel{L}}{\cancel{2}} \frac{\cancel{L}}{\frac{\cancel{L^2}}{2^{\cancel{2}}} \cdot \sqrt{2}\frac{L}{2}} = \frac{4}{\sqrt{2} L}$$

$$\bar{B}_1 = \frac{\mu_0 I}{4\pi} \frac{\cancel{4}}{\sqrt{2} L} (-\breve{e}_z) \Rightarrow \bar{B}_{TOT} = 4 \bar{B}_1 = \frac{4 \mu_0 I}{\pi \sqrt{2} L} (-\breve{e}_z)$$

Los 4 lados suman contribuciones en el mismo sentido entrante,