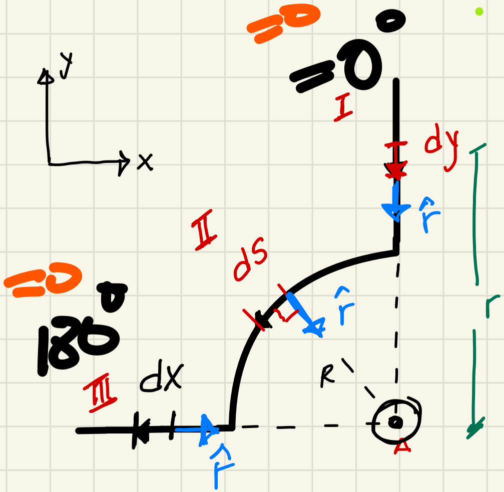
Fuentes de campo magnético

Ley de Biot-Savart

Física II

ing. Claudia Contreras



Ley de Biot - Savart.

$$dB = \frac{\mu_0}{4\pi} \frac{I\, d\vec{l} \times \hat{r}}{r^2}$$

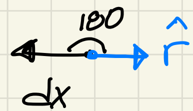
$\hat{r} \rightarrow$ magnitud uno

segmento I

$$\vec{dl} \times \vec{r} = \emptyset$$

$$\Rightarrow \vec{B}_I = \emptyset = 0$$

segmento III



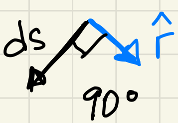
$$d\vec{l} \times \vec{r} = \emptyset$$

$$\Rightarrow \vec{B}_{III_A} = \emptyset = 0$$

$\mu = 4\pi$

segmento II

$ds = R\,d\theta$



$$dB_{II} = \frac{\mu_0 I}{4\pi} \frac{ds\,(1)\,\text{sen}\,90}{R^2} = \frac{\mu_0 I \cancel{R}\, d\theta}{4\pi R^{\cancel{2}}} = \frac{\mu_0 I}{4\pi R}\, d\theta \odot$$

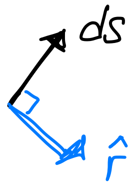
$$\vec{B}_{II} = \int_0^{\pi/2} \frac{\mu_0 I}{4\pi R}\, d\theta \odot = \frac{\mu_0 I}{4\cancel{\pi} R} * \frac{\cancel{\pi}}{2} = \frac{\mu_0 I}{8R} \odot$$

$$\vec{B}_A = \vec{B}_I + \vec{B}_{II} + \vec{B}_{III} = \frac{\mu_0 I}{8R} \odot$$

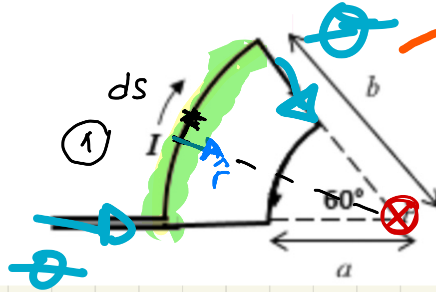
2. Un alambre lleva una corriente de I=3 A y se dobla en la forma de un arco, como se muestra en la figura, el radio a= 4 cm y el b= 10 cm. Los segmentos rectos están a lo largo de sus radios. La magnitud (en μT) y la dirección del campo producido en P por el arco de radio b es:

a) 1.80 ⊗	b) 1.80 ⊙	c) 3.14 ⊗	d) 3.14 ⊙	e) 4.50 ⊗

$$dB = \frac{\mu_0}{4\pi}\frac{I\,d\vec{l} \times \hat{r}}{r^2}$$



$ds = b\,d\theta$



$60° \to \frac{\pi}{3}$

dirección del B producido por el segmento de radio b

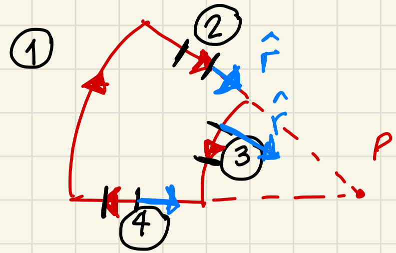
$$dB_1 = \frac{\mu_0}{4\pi}\frac{I\,ds\,(1)\,\text{sen}\,90}{b^2} = \frac{\mu_0}{4\pi}\frac{I\,\cancel{b}\,d\theta}{b^{\cancel{2}}} = \frac{\mu_0 I\,d\theta}{4\pi b}$$

$$B_1 = \int_0^{\pi/3}\frac{\mu_0 I}{4\pi b}\,d\theta = \frac{\mu_0 I}{\cancel{4}\pi b} * \frac{\cancel{\pi}}{3} = \frac{\mu_0 I}{12 b} \otimes = \frac{\cancel{4}\pi \times 10^{-7}(3)}{\cancel{12}(0.1)}\,T \otimes$$

$$\vec{B}_1 = \underline{3.142\,\mu T \otimes}$$

3. La magnitud (en µT) y la dirección del campo magnético total resultante en P, producido por todo el alambre es:

a) Cero	b) 4.71 $\odot$	c) 4.71 $\otimes$	d) 11.0 $\odot$	e) 11.0 $\otimes$



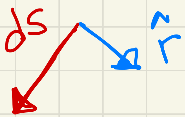
$$\vec{B}_p = \vec{B}_1 + \vec{B}_2 + \vec{B}_3 + \vec{B}_4$$

$$\vec{B}_{2p} = \emptyset \qquad \vec{B}_{1p} = 3.142\,\mu T \otimes$$

$$\vec{B}_{4p} = \emptyset$$

$ds = a\,d\theta$

segmento 3



$\odot\ B_{3p}$

$$dB = \frac{\mu_0}{4\pi}\frac{I\,ds\,(1)\,\mathrm{sen}\,90}{a^2} = \frac{\mu_0}{4\pi}\frac{I\,\cancel{a}\,d\theta}{a^{\cancel{2}}} = \frac{\mu_0 I\,d\theta}{4\pi a}$$

$$\vec{B}_3 = \int_0^{\pi/3} \frac{\mu_0 I\,d\theta}{4\pi a}\ \odot = \frac{\mu_0 I}{\cancel{4\pi} a} * \frac{\cancel{\pi}}{3} = \frac{\cancel{4}\pi\times10^{-7}(\cancel{3})}{\cancel{12}(0.04)}\ \odot\ T$$

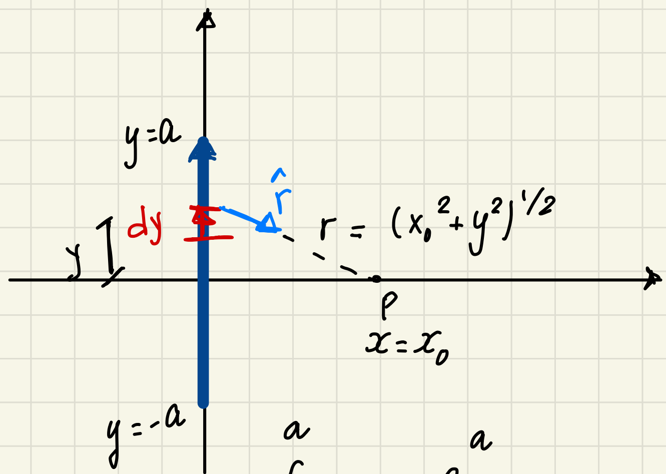
$$\vec{B}_3 = 7.854\,\mu T\ \odot$$

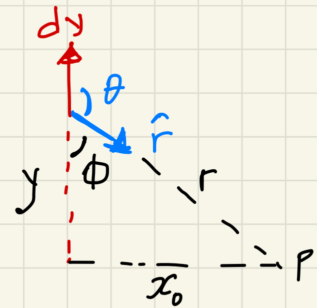
$$\vec{B}_p = 4.71\,\mu T\ \odot$$

para un segmento recto corto

$B_p = ?$

$$dB = \frac{\mu_0 I}{4\pi}\frac{d\vec{l}\times\hat{r}}{r^2}$$





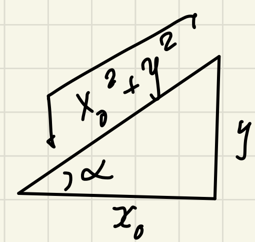
$$dB = \frac{\mu_0 I}{4\pi}\frac{dy\,(1)\,\text{sen}\,\theta}{(x_0^2+y^2)}$$

$$\text{sen}\,\theta = \text{sen}\,(180-\theta) = \text{sen}\,\phi$$

$$\text{sen}\,\theta = \frac{x_0}{r} = \frac{x_0}{\sqrt{x_0^2+y^2}}$$

$$B_p = \int_{-a}^{a} dB = 2\int_0^a \frac{\mu_0 I x_0\, dy}{4\pi\,(x_0^2+y^2)^{3/2}} \quad \otimes$$

$$= \frac{\mu_0 I x_0}{2\pi}\int_0^a \frac{dy}{(x_0^2+y^2)^{3/2}}$$



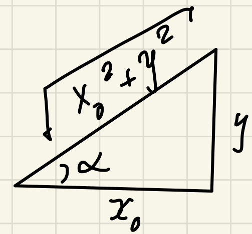
$$\tan\alpha = \frac{y}{x_0}$$

$$y = x_0 \tan\alpha$$

$$dy = x_0 \sec^2\alpha\, d\alpha$$

Simplifico ya

$$C_0 = \frac{\mu_0 I x_0}{2\pi} \int_0^a \frac{dy}{(x_0^2+y^2)^{3/2}}$$



$$\tan\alpha = \frac{y}{x_0}$$

$$y = x_0 \tan\alpha$$

$$dy = x_0 \sec^2\alpha \, d\alpha$$

$$\int \frac{x_0 \sec^2\alpha \, d\alpha}{[x_0^2 + x_0^2 \tan^2\alpha]^{3/2}}$$

$$\int \frac{\cancel{x_0} \sec^2\alpha \; d\alpha}{x^{\cancel{3}}(1+\tan^2\alpha)^{3/2}}$$

$$\frac{1}{x_0^2} \int \frac{\sec^2\alpha \, d\alpha}{\sec^3\alpha}$$

$$\frac{1}{x_0^2} \int \frac{d\alpha}{\sec\alpha} = \frac{1}{x_0^2} \int \cos\alpha \, d\alpha$$

$$= \frac{1}{x_0^2} \operatorname{sen}\alpha$$

$$\vec{B} = \frac{\mu_0 I \cancel{x_0}}{2\pi} * \frac{1}{x_0^{\cancel{2}}} \left[\frac{y}{\sqrt{x_0^2+y^2}} \Big|_0^a \right]$$

$$\vec{B}_P = \frac{\mu_0 I}{2\pi x_0} \cdot \frac{a}{\sqrt{x_0^2+a^2}} \otimes$$