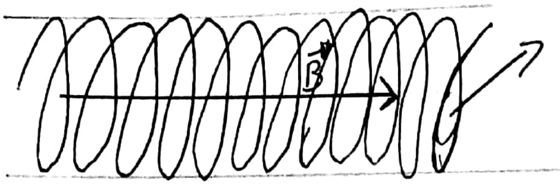
Tema 5: Problemas. Inducción electromagnética

1)



$d = 10\ cm \Rightarrow R = 0{,}05\ m$

$w =$ cte

$N = 20$

$B = 0{,}05\,T\ \perp$ al eje de giro

$\nu ? \Rightarrow$ f.e.m max $= 0{,}25\,V$

$w = \frac{\alpha}{t} \Rightarrow \alpha = wt$

$\Phi = \int \vec{B} \cdot d\vec{S} = \int B\,dS \cos(\alpha)$

$\mathcal{E} = -\frac{d\Phi}{dt} = -BS\,w\,\text{sen}\,\cancel{\cos}\,(wt)$

Para $\mathcal{E}$ max sen $= 1$

$\mathcal{E} = BS\,w \cdot N$

$0{,}25 = 0{,}05 \cdot \pi (0{,}05)^2 \cdot w \cdot 20$

$S = \pi R^2 = \pi (0{,}05)^2$

$w = \frac{0{,}25}{0{,}05 \cdot (0{,}05)^2 \cdot \pi \cdot 20} = 31{,}83$

$w = \cancel{636{,}62\ rad/s}\ 31{,}83\ rad/s$

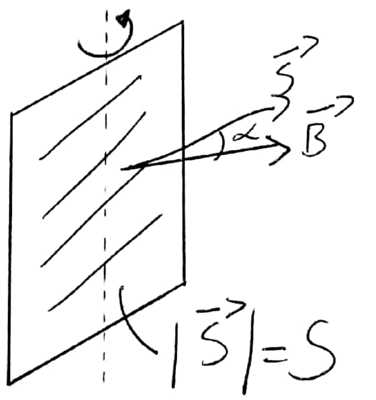
$w = \frac{2\pi}{T}$

$T = \frac{2\pi}{w}$

$w = 2\pi\nu$

$\boxed{\nu = \frac{w}{2\pi} = \frac{\cancel{636{,}62}\ 31{,}83}{2\pi} = 5{,}06\ Hz}$

2)



$B = 0{,}5\,G = 0{,}5$

S para que $V_e = 220V$ a $50Hz$

$V_e = \frac{V_0}{\sqrt{2}}$ $\qquad \nu = 50Hz$

V_e = Potencia eficaz

$V_0 = V_e\sqrt{2} = 220\sqrt{2}$

$$\mathcal{E} = -\frac{d\Phi}{dt} = -\frac{d(BS\cos(wt))}{dt} = -BS\,\cancel{w}\,\text{sen}\, wt$$

$$\Phi = \vec{B}\vec{S} = BS\cos\alpha = \boxed{BS\cos(wt)}$$

$$w = \frac{\alpha}{t} \Rightarrow \alpha = wt$$

$$\mathcal{E} = -\underbrace{NBSw}_{\mathcal{E}_0 = V_0}\ \text{sen}\, wt$$

$$w = 2\pi\nu = 2\pi\nu = 2\pi\, 50 = 100\pi\ \text{rad/s}$$

$$\mathcal{E}_0 = V_0$$

$$NBSw = 220\sqrt{2}$$

$$S = \frac{220\sqrt{2}}{NB\cancel{S}w} = \frac{220\sqrt{2}}{1000 \cdot 0{,}5 \cdot 10^{-4} \cdot 100\pi} =$$

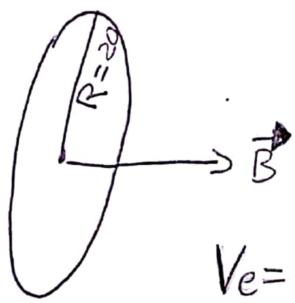
$$S = 19{,}80\ m^2$$

3) $\nu = 1\,MHz = 10^6\,Hz$ $\quad R = 20\,cm = 0{,}2\,m$ $\quad B = B_0\ \text{sen}(wt)$

$B_0 = 10^{-6}\,T$

$$w = 2\pi\nu = 2\pi \cdot 10^6\ \text{rad/s}$$

B max si sen $= 1$



Tensión eficaz de salida o potencia eficaz

$$V_e = \frac{V_0}{\sqrt{2}} \Rightarrow V_0 = V_e\sqrt{2}$$

$$\mathcal{E} = -\frac{d\Phi}{dt} = -\frac{d(BS\cos(wt))}{dt} =$$

$$\Phi = \vec{B}\vec{S} = BS\cos(wt)$$

$$w = \frac{\alpha}{t} \Rightarrow \alpha = wt$$

$$S = \pi (0{,}2)^2$$

$$S = 0{,}04\pi\ m^2$$

$$\mathcal{E}_0 = V_0$$

$$\mathcal{E} = \cancel{-}BSw\,\text{sen}(wt)$$

$$BSw = V_e\sqrt{2}$$

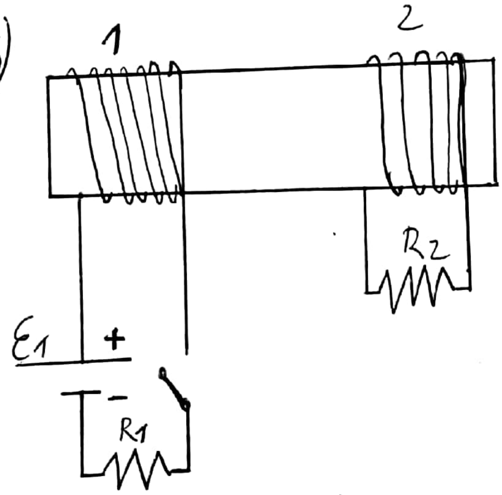
$$V_e = \frac{BSw}{\sqrt{2}} = \frac{10^{-6} \cdot \pi \cdot 0{,}04 \cdot 2\pi \cdot 10^6}{\sqrt{2}}$$

$$\mathcal{E}_{max} = BSw$$

$$V_e = 0{,}56\,V$$

4)

5)



Indica el sentido de la corriente en R2.

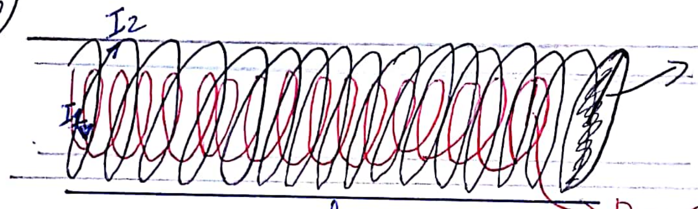
a) inicialmente, tal como se ve en la figura.
0 ya que el interruptor está desactivado y no permite el paso de corriente.

b) en el instante en el que se cierra el interruptor

c) al cabo de varios minutos cuando la corriente en el circuito 1 se ha estabilizado.

d) en el instante en que se vuelve a abrir el interruptor.

6)

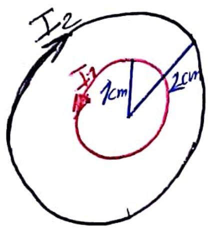


$R_2 = 2\,cm = 0{,}02\,m$

$R_1 = 1\,cm = 0{,}01\,m$

$I_1 = I_2 = 1A$ $\quad l = 50\,cm = 0{,}5\,m$

I_1 e I_2 sentidos contrarios



$$\left[U = \frac{1}{2\mu_0} B^2\right]$$

$$U = \frac{1}{2} L I^2$$

$r < R_1,\ B = 0 \qquad \oint \vec{B}\,d\vec{l} = \mu_0 (I_{int}) = 0$

$r > R_2\ B = 0 \qquad \oint \vec{B}\,d\vec{l} = \mu_0 \underbrace{(I_1 + I_2)} = 0$

se restan en verdad, ya que van en sentido opuesto.

$R_1 < R < R_2$

$$\oint \vec{B}\, d\vec{l} = \mu_0 (I_{int})$$

$$B\, 2\pi R = \mu_0 I$$

$$B = \frac{\mu_0 I}{2\pi R}$$

$$U = \frac{1}{2\mu_0} \cdot \left(\frac{\mu_0 I'}{2\pi R} \right)^2 =$$

$$=$$

Tenemos que encontrar

$a = 0{,}01 \quad b = 0{,}02$

$$I' \Rightarrow J = \frac{I}{S} = \frac{2}{\pi (b^2 - a^2)}$$

$$S = \pi b^2 - \pi a^2 = \pi (b^2 - a^2)$$

$$I' = \frac{2}{\cancel{\pi} (b^2 - a^2)} \cdot \cancel{\pi} (R^2 - a^2) = \frac{2 (R^2 - a^2)}{b^2 - a^2} =$$

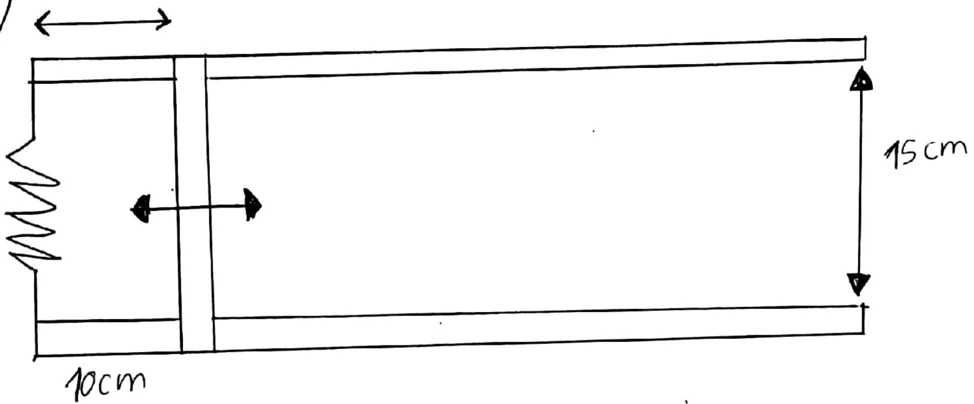
$$I' = J \cdot S$$

$$= \frac{2 (R^2 - 0{,}01^2)}{0{,}02^2 - 0{,}01^2} =$$

$$= \frac{2R^2 - 2 \cdot 0{,}01^2}{0{,}0003} = \frac{2R^2 - 0{,}0002}{0{,}0003}$$

$$S' = \pi (R^2 - a^2)$$

7)



Alto = 15 cm

ancho = 10 cm.

$y(t) = 10 + 5\,\text{sen}\,(t+\pi)$

$B \otimes = 0{,}5\ T$

$$\mathcal{E} = -\frac{d\Phi}{dt} = -B\frac{dS}{dt} = -B\,l\,dy = -B\,l\cos(t+\pi) =$$

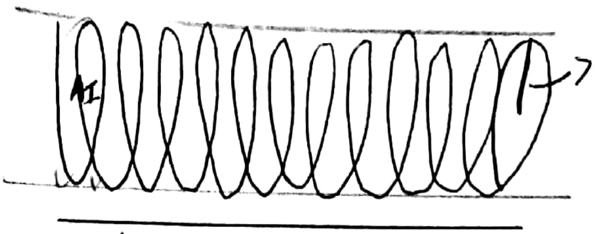
$$S = l \cdot y(t)$$

$$\Phi = \vec{B}\vec{S} = BS\,\cancel{\cos 0}^{\,1}$$

$$I = \frac{\mathcal{E}}{R} = -\frac{B}{R}\,l\cos(t+\pi) = \frac{-B}{R}\,15\cdot 10^{-4}(t+\pi)$$

8

$N = 1000$



$R = 1\,cm = 0{,}01\,m$ $\quad I = 100\,mA$

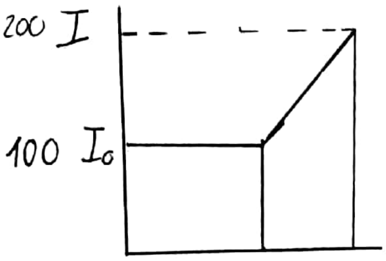
$S = \pi R^2 = \pi (0{,}01)^2\,m^2$

$l = 10\,cm = 0{,}1\,m$

a)

$$L = \frac{\mu_0 N^2 S}{l} = \frac{4\pi \cdot 10^{-7} \cdot 1000^2 \cdot \pi (0{,}01)^2}{0{,}1} = 3{,}94 \cdot 10^{-3}\,H$$

b) f.e.m si en 10 ms $I_0 \Rightarrow I_f = 200\,mA$



$$\varepsilon = -L\frac{dI}{dt} \Rightarrow \left[\varepsilon = -L\frac{\Delta I}{\Delta t} = 3{,}94 \cdot 10^{-3} \cdot \frac{0{,}1}{0{,}01} = -0{,}0394\,V\right]$$

$\Delta I = 200 - 100 = 100\,mA$

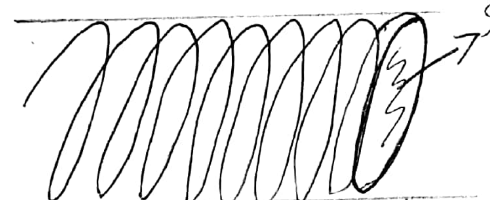
$\Delta t = 10\,ms$

La f.e.m autoinducida es la que nace durante el cambio de corriente de 100 mA a 200 mA.

La f.e.m es una consecuencia de la corriente inicial que cambia

9)

$S = 20\,cm^2 = 0{,}02\,m^2$ $\quad N = 200$



$I = 2\,sen(20t) \Rightarrow dI = 20 \cdot 2 \cdot \cos(20t)$

$l = 10\,cm = 0{,}1\,m$

a) L?

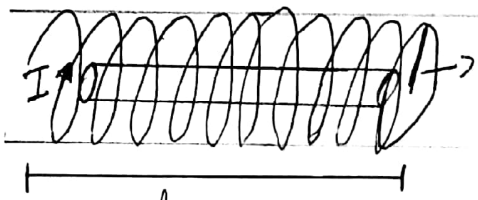
$$L = \frac{\mu_0 N^2 S}{l} = \frac{4\pi \cdot 10^{-7} \cdot 200^2 \cdot 0{,}02}{0{,}1} = 0{,}01 = 10^{-3}\,H$$

b) f.e.m en $t=3s$

$$\mathcal{E} = -L\frac{dI}{dt} = -\underbrace{10^{-3}\cdot 2\cdot 20}_{\mathcal{E}_0}\cos 20t \ V$$

$$\mathcal{E}(t=3) = -40\cdot 10^{-3}\cdot \cos(20\cdot 3) = -0{,}02 = -20\cdot 10^{-3} V$$

10)



$R = 1cm = 0{,}01m$

$l = 20cm = 0{,}2m$

Fe $\mu_r = 5000$

$N = 300$

$I = 2A$

$$\mu_r = \frac{\mu}{\mu_0} \Rightarrow \mu = \mu_r\cdot\mu_0 = 5000\cdot 4\pi\cdot 10^{-7} = 6{,}28\cdot 10^{-3}$$

$$B = \mu n I = \overset{5000}{\cancel{6{,}28\cdot 10^{-3}}}\cdot\frac{300}{0{,}2}\cdot 2 = \overset{15\cdot 10^{6}\ T}{\cancel{18{,}84\ T}}$$

a) L?

$$L = \frac{\mu_0 N^2 S}{l} = \frac{4\pi\cdot 10^{-7}\cdot 300^2\cdot \pi(0{,}01)^2}{0{,}2} = 0{,}89 H$$

b) U_B almacenada en el solenoide.

$$U_B = \frac{1}{2\mu}B^2 = \frac{1}{2\cdot 6{,}28\cdot 10^{-3}}\cdot(\overset{15\cdot 10^{6}}{\cancel{18{,}84}})^2 = \cancel{28\,260}\ J$$

$$U = u\cdot \text{Volumen} = 28\,260\cdot \pi R^2\cdot l = 28\,260\cdot \pi(0{,}01)^2\cdot 0{,}2 =$$

$$= 1{,}78\ J/m^3.$$

Cambiar