HOJA N°

FECHA

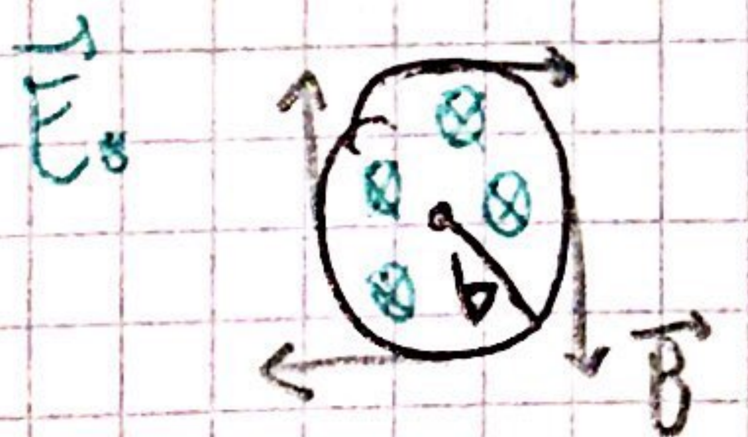
PRACTICO 10

1

B es uniforme radialmente alrededor del eje x

acá no hay i_n, solo hay $i_d \Rightarrow \oint \vec{B}\, d\vec{l} = \mu_0 . i_d$

Desde arriba:



$$\oint \vec{B}\, dL = \mu_0\, i_d = \mu_0\, \varepsilon_0 \frac{d\Phi_E}{dt}$$

$$\Phi_E = \int_0^{2\pi}\int_0^{r} E\, r\, dr\, d\theta = E \pi r^2$$

$$\frac{d\Phi_E}{dt} = \frac{dE}{dt} \cdot \pi r^2$$

Luego:

$$\oint \vec{B}\, d\vec{L} = \mu_0\, \varepsilon_0 \frac{dE}{dt} \pi r^2$$

$$B\, 2\pi r = \mu_0\, \varepsilon_0 \frac{dE}{dt} \pi r^2$$

NOTA

$$\Longrightarrow \vec{B}(T) = \frac{\mu_0 \varepsilon_0 I}{2} \cdot \frac{dE}{dT}$$

Además:

<u>Cuando descarga</u>

$$E(T) = \frac{q(t)}{\varepsilon_0 A} \hat{x}$$

$$\frac{dE}{dT} = \frac{i(t)}{\varepsilon_0 A} \hat{x}$$

<u>Cuando carga</u>

$$E(t) = \frac{q(t)}{\varepsilon_0 A} \cdot \hat{x}$$

$$\frac{dE}{dT} = \frac{i(t)}{\varepsilon_0 A} \cdot \hat{x}$$

Vector de onda: $K = \frac{2\pi}{\lambda}$

Frecuencia: $f = \frac{\omega}{2\pi} = \frac{1}{T}$

Periodo: $T = \frac{2\pi}{\omega}$

Función: $f(x,T) = A\sin(Kx - \omega T)$ $\leadsto$ x-algo $\leadsto$ se propaga en $\hat{x}$; x+algo $\leadsto$ se propaga en $-\hat{x}$

$= A\sin\left(\frac{2\pi}{\lambda}(x - VT)\right)$

Velocidad: $V = \frac{\omega}{K} = \frac{\lambda}{T} = \lambda \cdot f$ λ: longitud de onda

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$\Psi_1 = \underbrace{4}_{\text{amplitud}} \cdot \sin\left(2\pi \cdot \frac{0{,}2}{m}\left(x - \frac{3}{0{,}2}\frac{m}{s} \cdot T\right)\right)$ $\leadsto$ se propaga en $\hat{x}$

$= 4\sin\left(\underbrace{\frac{2\pi}{5m}}_{\lambda = 5m}\left(x - 25\frac{m}{s} \cdot T\right)\right)$

$= 4\sin\left(\frac{2\pi}{5} \cdot \frac{x}{m} - \frac{6\pi}{s} \cdot T\right)$ $\leadsto$ $\omega = 6\pi \cdot \frac{1}{s}$

$\Longrightarrow f = \frac{6\pi}{2\pi} \cdot \frac{1}{s} = 3 \cdot \frac{1}{s} \Longrightarrow T = \frac{1}{3} \cdot s$

NOTA

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$$\psi_2 = \frac{2}{5}\sin\left(\frac{7}{m}\cdot z - \frac{3,5}{s}\cdot T\right) = \frac{2}{5}\sin\left(\frac{7}{m}\left(z - \frac{3,5}{7}\frac{m}{s}\cdot T\right)\right)$$

$$\omega = 3,5\cdot\frac{1}{s} \quad , \quad f = \frac{3,5}{2\pi}\cdot\frac{1}{s} \quad , \quad T = \frac{2\pi}{3,5}\cdot\frac{1}{s}$$

$$\frac{7}{m} = \frac{2\pi}{\lambda} \Rightarrow \lambda = \frac{2\pi}{7}\,m$$

$$A = \frac{2}{5}$$

dir: $\hat{z}$

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$$\left.\begin{aligned}\vec{E}(x,T) &= E_0 \sin(Kx+\omega T)\,\hat{k}\\ \vec{B}(x,T) &= B_0 \sin(Kx+\omega T)\,\hat{j}\end{aligned}\right\}$$ eligiendo ejes ve ares, el vector de poynting apunte en la dirección $-\hat{i}$.

Por maxwell:

$$\nabla\times\vec{B} = \varepsilon_0\mu_0\frac{\partial\vec{E}}{\partial t} \qquad \nabla\times\vec{B}: \begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z}\\ 0 & \vec{B} & 0\end{vmatrix} \qquad \begin{aligned}\hat{i}&=0\\ \hat{j}&=0\\ \hat{k}&=KB_0\cos(Kx+\omega T)\end{aligned}$$

$$\frac{\partial\vec{E}}{\partial T} = E_0\omega\cos(Kx+\omega T)\,\hat{k}$$

Entonces:

$$KB_0\cos(Kx+\omega T) = E_0\omega\cos(Kx+\omega T)\,\varepsilon_0\mu_0$$

$$\boxed{KB_0 = E_0\omega\,\varepsilon_0\mu_0} \quad (1)$$

NOTA

Y Tambien: $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

$$\nabla \times \vec{E} : \left| \begin{array}{ccc} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 0 & 0 & \vec{E} \end{array} \right| \begin{array}{l} \hat{i} = 0 \\ \hat{j} = kE_0 \cos(kx + wt) \\ \hat{k} = 0 \end{array}$$

$$-\frac{\partial \vec{B}}{\partial t} = -B_0 w \cos(kx + wt)$$

Entonces:

$$kE_0 \cos(kx + wt) = -B_0 w \cos(kx + wt)$$

$$\boxed{kE_0 = -B_0 w} \quad (2)$$

Luego:

$$\begin{cases} \alpha & kB_0 = E_0 w \varepsilon_0 \mu_0 \\ \beta & kE_0 = -B_0 w \end{cases} \rightsquigarrow B_0 = \frac{-kE_0}{w}$$

Reemplazo en α:

$$\frac{-k^2 E_0}{w} = E_0 w \varepsilon_0 \mu_0$$

$$k = \sqrt{-w^2 \varepsilon_0 \mu_0} \rightsquigarrow \text{(No sé que pasó con el signo)}$$

Finalmente:

$$\vec{E} = \frac{B_0}{\sqrt{-w^2 \varepsilon_0 \mu_0}} \sin\left(\sqrt{-w^2 \varepsilon_0 \mu_0}\, x + wt\right) \hat{k}$$

$$\vec{B} = B_0 \sin\left(\sqrt{-w^2 \varepsilon_0 \mu_0}\, x + wt\right)$$

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$$\vec{E} = \overbrace{\frac{E_0 l^2}{l^2+(x+cT)^2}}^{E}\hat{\jmath} \quad , \quad \vec{B} = \overbrace{-\frac{l^2 E_0}{c(l^2+(x+cT)^2)}}^{B}\hat{k}$$

$$\vec{E} = (0, E, 0) \quad , \quad \vec{B} = (0,0,B)$$

No hay q, ni i. Por lo tanto deberían cumplir:

I) $\nabla . \vec{E} = 0$ II) $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial T}$ III) $\nabla . \vec{B} = 0$ IV) $\nabla \times \vec{B} = \varepsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial T}$

I)

$$\frac{\partial \vec{E}_1}{\partial x} = 0$$

$$\frac{\partial \vec{E}_2}{\partial y} = 0 \quad \Rightarrow \quad \nabla . \vec{E} = 0 \checkmark$$

$$\frac{\partial \vec{E}_3}{\partial z} = 0$$

II)

$$\nabla \times \vec{E} = \left(-\frac{\partial E}{\partial z}, 0, \frac{\partial E}{\partial x}\right) = \left(0, 0, -\frac{2l^2 E_0 (x+cT)}{(l^2+(x+cT)^2)^2}\right)$$

$$\frac{\partial \vec{B}}{\partial T} = \left(0, 0, \frac{2l^2c^2E_0(x+cT)}{(l^2c+c(x+cT)^2)^2}\right) = \left(0, 0, \frac{2l^2E_0(x+cT)}{(l^2+(x+cT)^2)^2}\right)$$

$$\Rightarrow \nabla \times \vec{E} = \frac{\partial \vec{B}}{\partial T} \checkmark$$

III)

$$\frac{\partial \vec{B}_1}{\partial x} = 0$$

$$\frac{\partial \vec{B}_2}{\partial y} = 0 \quad \Rightarrow \quad \nabla . \vec{B} = 0 \checkmark$$

NOTA $\frac{\partial \vec{B}_3}{\partial z} = 0$

IV)

$$\nabla \times \vec{B} = \left(\frac{\partial B}{\partial z}, -\frac{\partial B}{\partial x}, 0\right) = \left(0, \frac{-2\ell^2 c E_0 (x+ct)}{(\ell^2 c + c(x+ct)^2)^2}, 0\right)$$

$$\frac{\partial \vec{E}}{\partial t} = \left(0, \frac{-2\ell^2 c E_0 (x+ct)}{(\ell^2 + (x+ct)^2)^2}, 0\right)$$

Sabemos que $c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}} \Rightarrow c^2 = \frac{1}{\varepsilon_0 \mu_0} \Rightarrow \varepsilon_0 \mu_0 = \frac{1}{c^2}$

$$\Rightarrow \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t} = \frac{1}{c^2} \cdot \frac{\partial \vec{E}}{\partial t} = \left(0, \frac{-2\ell^2 c E_0 (x+ct)}{(\ell^2 c + c(x+ct)^2)^2}, 0\right)$$

$$\Rightarrow \nabla \times \vec{B} = \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$$

Además $\vec{S} = \mu_0 (\vec{E} \times \vec{B})$ apunta en la dirección de la onda, luego:

$\hat{j} \times \hat{k} = \hat{i}$ no apunta en $\hat{i}$

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$$I = \frac{E_0 B_0}{2\mu_0} = \frac{B_0}{2\mu_0} \cdot E_0 = \frac{B_0}{2\mu_0} \cdot c B_0 = B_0^2 \cdot \frac{c}{2\mu_0}$$

$$\Rightarrow B_0^2 = \frac{2 I \mu_0}{c}$$

El valor cuadrático medio es $B^2 = \frac{B_0^2}{2}$. Luego:

$$B^2 = \frac{I \mu_0}{c} = 10^3 \frac{W}{m^2} \cdot 4\pi 10^{-7} \frac{T m}{A} \cdot \frac{1}{399 \cdot 10^3} \cdot \frac{s}{m} = 4{,}2 \cdot 10^{-12}\, T^2$$

NOTA

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$$I = \frac{10 KW}{Area} = \frac{10\ kW}{500^2 Km^2 \pi}$$

$$I = \frac{E_0 B_0}{2\mu_0} = \frac{E^2}{2C\mu_0}$$

$$\Longrightarrow E^2 = \frac{10\ kW}{500^2 Km^2 \pi} \cdot 2\mu_0 C$$

$$E = \sqrt{\frac{10^4\ W}{\pi 500^2 Km^2} \cdot 2 \cdot 4\pi 10^{-7} \cdot \frac{Tm}{A} \cdot 2{,}99 \frac{m}{s}}$$

mili

$$= \sqrt{0{,}95 \cdot 10^{-13}}\ \frac{V}{m} = 3{,}08 \cdot 10^{-7}\ \frac{V}{m} = 3{,}08 \cdot 10^{-7}\ \frac{mV}{m}$$

NOTA