Workshop 5 : Ondas Electromagnéticas

P - 1. $\vec{S} = \frac{1}{\mu_0}(\vec{E} \times \vec{B})$ provee la dirección de la onda.

$\vec{S} = S\,\hat{S}$ donde $\hat{S}$ es un vector unitario en la dirección de $\vec{S}$. Además,

$$\hat{S} = \hat{E} \times \hat{B}$$

$$\downarrow$$

$$\hat{j} = \hat{k} \times \hat{B} \Rightarrow \hat{B} = \hat{i}$$

$\therefore \vec{B}$ apunta en la dirección $+x$ (ó $\hat{i}$).

P - 2 $c = v = \lambda f$ donde c es constante $(3 \times 10^8\ m/s)$

$$\Rightarrow f = \frac{c}{\lambda} \Rightarrow f_{max} = \frac{c}{\lambda_{min}} = \frac{3\times10^8\ m/s}{400\ nm}$$

$$= \frac{3 \times 10^8\ m/s}{4 \times 10^{-7}\ m} = 0.75 \times 10^{15}\ Hz$$

$$= 7.5 \times 10^{14}\ Hz$$

P - 3 $E = cB$; $\frac{570\ N/C}{3\times10^8\ m/s} = B = 1.9 \times 10^{-6}\ T$

P - 4 $\vec{S} = \frac{1}{\mu_0}(\vec{E} \times \vec{B}) = \frac{1}{\mu_0}(E\hat{E} \times B\hat{B})$

$$= \frac{EB}{\mu_0}(\hat{E} \times \hat{B})$$

$$\Rightarrow S = \frac{EB}{\mu_0} \quad y \quad \hat{S} = \hat{i}$$ (dado por el problema)

$$\vec{S} = \frac{EB}{\mu_0}\hat{r} = \frac{E^2}{c\mu_0}\hat{r} = \frac{(0.082 \text{ V/m})^2}{(3\times10^8 \text{ m/s})(4\pi\times10^{-7} \text{ T·m/A})}\hat{r}$$

$$\approx 1.78\times10^{-5} \text{ W/m}^2$$

P-5 $\langle S\rangle = 0.724 \text{ W/m}^2$

$$\langle S\rangle = \frac{E_{max}B_{max}}{2\mu_0} = \frac{cB_{max}^2}{2\mu_0}$$

$$\Rightarrow B_{max} = \left(\frac{2\mu_0\langle S\rangle}{c}\right)^{1/2} = \left[\frac{2(4\pi\times10^{-7} \text{ T·m/A})(0.724 \text{ W/m}^2)}{3\times10^8 \text{ m/s}}\right]^{1/2}$$

$$\approx 7.79\times10^{-8} \text{ T}$$

P-6 $\langle S\rangle = \frac{1\times10^{-3} \text{ W}}{\pi(1\times10^{-3} \text{ m})^2} = \frac{1 \text{ W}}{\pi(1\times10^{-3} \text{ m})} \approx 318.3 \text{ W/m}^2$

$$\langle S\rangle = \frac{E_{max}B_{max}}{2\mu_0} = \frac{E_{max}^2}{2c\mu_0}$$

$$\Rightarrow E_{max} = (2c\mu_0\langle S\rangle)^{1/2} = (2\cdot3\times10^8 \text{ m/s}\cdot4\pi\times10^{-7} \text{ T·m/A}\cdot318 \text{ W/m}^2)^{1/2}$$

$$\approx 489.9 \text{ N/C}$$

P-7 u ← densidad de energía; U ← energía

$$u = \frac{U}{V} \qquad u = \varepsilon_0 E_{max}^2 \qquad I = \langle S\rangle = \frac{E_{max}B_{max}}{2\mu_0 c} = \frac{E_{max}^2}{2c\mu_0}$$

$$E_{max}^2 = 2c\mu_0\langle S\rangle$$

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

$$V = \frac{U}{u} = \frac{U}{\varepsilon_0 \cdot 2c\,\mu_0 \langle S \rangle} = \frac{U\,c}{2\langle S \rangle}$$

$$= \frac{(1.0\ J)\ (3\times10^8\ m/s)}{2 \cdot 1.35\times10^3\ W/m^2} \approx \boxed{4285\ m^3}$$