ÖDEV 2

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1-) Havada yayılan düzlem dalga

a) $E(y,z) = (2e_y + e_z)\cos(\omega t - 4y + 3z)$ [V/m]

$k = kn = k_y \vec{e_y} + k_z \vec{e_z}$, $r = y\vec{e_y} + z\vec{e_z}$ için

$E = \vec{e_y}\, 2e^{-Jkr} + \vec{e_z}\, e^{-Jkr}$

$e^{-J\omega t}$ zaman bağlılığında $k_y = 4$, $k_z = -3$; $k^2 = k_y^2 + k_z^2 \Rightarrow \underline{k = 5}$

b)

$\frac{\omega}{c} = k$ $\omega = 5 \times 3 \cdot 10^8 = 15 \times 10^8$ (Açısal frekans)

$\lambda = \frac{2\pi}{5} = 0{,}4\pi$ // (Dalga boyu)

c) $e^{-J\omega t}$ zaman bağlılığında

$\{e^{-J\omega t} \cdot e^{J(4y-3z)}\} \rightarrow \vec{n} = \frac{4}{5}\vec{e_y} - \frac{3}{5}\vec{e_z}$ → Yayılma yönü

d) $E = \vec{e_y}\, 2\cos(\omega t - 4y + 3z) + \vec{e_z}\cos(\omega t - 4y + 3z)$

$\frac{E_y}{E_z} = \frac{2\cos(\omega t - 4y + 3z)}{\cos(\omega t - 4y + 3z)} = 2$ Aralarında 2:1 oran var (Doğrusal)
Lineer polarizasyon diyebiliriz.

2-) $\frac{\varepsilon''}{\varepsilon'} \gg 1$ iyi iletken değilse zayıf iletken

$\varepsilon'' = 9{,}5 \times 10^{-12}$

$\varepsilon' = 2\varepsilon_0 = 2 \cdot \frac{1}{36\pi} \cdot 10^{-9}$

$\frac{\varepsilon''}{\varepsilon'} = \frac{9{,}5 \times 10^{-12}}{2 \cdot \frac{1}{36\pi} \cdot 10^{-9}} = 0{,}53$ → zayıf iletken

$\omega = 2\pi \cdot 3 \times 10^9$

$\alpha = \omega \frac{\varepsilon''}{2}\sqrt{\frac{\mu}{\varepsilon'}}$ (Zayıflama sabiti) $\Rightarrow \alpha = 2\pi \cdot 3 \times 10^9 \times \frac{9{,}5 \times 10^{-12}}{2}\sqrt{\frac{4\pi \times 10^{-7}}{\frac{2}{36\pi} \times 10^{-9}}} \cong 23{,}868$

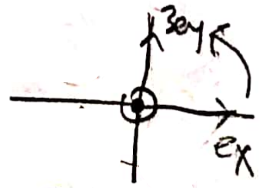
$\beta = \omega\sqrt{\varepsilon'\mu}\left[1 + \frac{1}{8}\left(\frac{\varepsilon''}{\varepsilon'}\right)^2\right]$ (Faz sabiti) $\Rightarrow \beta = 2\pi \times 3 \times 10^9 \sqrt{\frac{2}{36\pi} \cdot 10^{-9} \cdot 4\pi 10^{-7}}\left[1 + \frac{1}{8}\left(\frac{9{,}5 \times 10^{-12}}{\frac{2}{36\pi} \cdot 10^{-9}}\right)\right] \cong 92{,}063$

$k = \beta + \alpha J = 92{,}063 + J\, 23{,}868$

b) $\vec{E}(z) = \vec{e_x} \cdot e^{-\alpha z} \cdot e^{J\beta z} + \vec{e_y}\, 3e^{-\alpha z} \cdot e^{J(\beta z + \pi/2)}$

→ Genlikler farklı ⇒ Eliptik polarizasyon
→ Faz farkı var

$z=0$ için $\omega t = 0 \Rightarrow \vec{e_x}$
$\omega t = \pi/2 \Rightarrow 3\vec{e_y}$



Sağ el - eliptik polarizasyon

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c) $z=0{,}3m$ konumundaki elektrik alan vektörü

$$\vec{E}(z) = e^{-23{,}868z}\left[\cos(92{,}063-wt)\vec{e_x} - 3\sin(92{,}063-wt)\vec{e_y}\right]$$

$$z=0{,}3m \quad = 7{,}67\times10^{-4}\left[\cos(92{,}063-wt)\vec{e_x} - 3\sin(92{,}063-wt)\vec{e_y}\right]$$

3-)

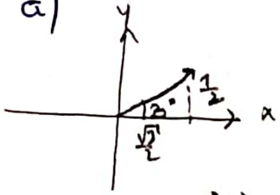
$E_0 = 12{,}4 \qquad |P| = 1{,}2$

$$z = \frac{|E|}{|H|} \qquad |P| = |E|\cdot|H| \rightarrow 1{,}2 = 12{,}4|H| \rightarrow |H| = 0{,}096$$

$$z = \frac{12{,}4}{0{,}096} = 128{,}13 \qquad z = \sqrt{\frac{\mu}{\varepsilon}} \rightarrow \frac{z}{\mu_0} = \frac{1}{\sqrt{\varepsilon\mu_0}} \Rightarrow V = 10^8\, m/s$$

4)

a)



$$\vec{n} = \frac{\sqrt{3}}{2}\vec{a_x} + \frac{1}{2}\vec{e_y} \qquad \vec{n_H} = \vec{e_z} \qquad E = -\eta\, \vec{n}\times\vec{H}$$

$$E = -\left[\frac{\sqrt{3}}{2}\vec{e_x}\times\vec{e_z} + \frac{1}{2}\vec{e_y}\times\vec{e_z}\right]$$

$$E = +\vec{e_y}\frac{\sqrt{3}}{2} - \frac{1}{2}\vec{e_x}\,]$$

$$\vec{E} = E_0\cdot e^{-jk\vec{n}\vec{r}}$$

$$\vec{n_E} = -\vec{e_x}\, e^{\left(-\frac{\sqrt{3}}{2}x - \frac{1}{2}y\right)}\cdot e^{-j(2\sqrt{3}x+2y)} + \sqrt{3}\vec{e_y}\, e^{\left(-\frac{\sqrt{3}}{2}x - \frac{1}{2}y\right)}\cdot e^{-j(2\sqrt{3}x+2y)}$$

$$\vec{H} = \frac{1}{\eta}\cdot\vec{n}\times\vec{E}$$

$$\eta = \sqrt{\frac{\mu}{\varepsilon}} = \sqrt{\frac{\mu_0}{\varepsilon - \frac{j\sigma}{w}}} = \sqrt{\frac{\mu_0}{\varepsilon_0\left(\varepsilon_r - \frac{j\sigma}{w\varepsilon_0}\right)}} \qquad \varepsilon_r = \frac{Re\{k^2\}}{w^2\cdot\mu\cdot\varepsilon_0}, \quad \sigma = \frac{Im\{k^2\}}{w\mu}$$

$$= \frac{\eta_0}{\sqrt{\varepsilon - \frac{j\sigma}{w\varepsilon_0}}} \qquad \eta = 185{,}7 + 46j$$

$$\vec{H} = \frac{1}{(185{,}7+46j)}\left[\frac{3}{2}\vec{e_z}\, e^{\left(-\frac{\sqrt{3}}{2}x - \frac{1}{2}y\right)}\cdot e^{-j(2\sqrt{3}x+2y)} + \frac{\vec{e_z}}{2}\, e^{\left(-\frac{\sqrt{3}}{2}x - \frac{1}{2}y\right)}\cdot e^{-j(2\sqrt{3}x+2y)}\right]$$

b) %10 için $\quad e^{-\frac{\sqrt{3}}{2}x - \frac{1}{2}y} = \frac{1}{10}$ olmalı

$$\ln 10 = \frac{\sqrt{3}}{2}x + \frac{1}{2}y = 2{,}3$$

$y = 1m$ için $\frac{\sqrt{3}x}{2} = 1{,}8$

$$x = \frac{3{,}6}{\sqrt{3}} = 2{,}078m$$

c) $x = 2m,\ y = 3m$

$$\vec{E} = -\vec{e_x}\, e^{(-\sqrt{3}-1{,}5)}\cdot e^{-j(4\sqrt{3}+6)} + \sqrt{3}\vec{e_y}\, e^{(-\sqrt{3}-1{,}5)}\cdot e^{-j(4\sqrt{3}+6)}$$

$$\vec{E} = (0{,}37 - j0{,}014)\,-\vec{e_x} + (0{,}0641 - j0{,}024)\,\vec{e_y}$$