1)

a)

$$\boldsymbol{E} = 2e^{j(k_y y + k_z z)}\boldsymbol{e}_y + e^{j(k_y y + k_z z)}\boldsymbol{e}_z = 2e^{j(4y-3z)}\boldsymbol{e}_y + e^{j(4y-3z)}\boldsymbol{e}_z$$

$$k_y = 4; \quad k_z = -3; \qquad k^2 = k_y^2 + k_z^2 \quad \Rightarrow \quad k = 5$$

b)

$$\omega = kc = 15 \times 10^8\, rad/s \qquad , \qquad \lambda = \frac{2\pi}{k} = \frac{2\pi}{5} = 0.4\pi$$

c)

$$\boldsymbol{E} = 2e^{j\boldsymbol{kr}}\boldsymbol{e_y} + e^{j\boldsymbol{kr}}\boldsymbol{e_z} = 2e^{jk\boldsymbol{nr}}\boldsymbol{e_y} + e^{jk\boldsymbol{nr}}\boldsymbol{e_z}$$

$$= 2e^{j5\left(\frac{4}{5}y-\frac{3}{5}z\right)}\boldsymbol{e_y} + e^{j5\left(\frac{4}{5}y-\frac{3}{5}z\right)}\boldsymbol{e_z} \quad \Rightarrow \quad \boldsymbol{n} = \frac{4}{5}\boldsymbol{e_y} - \frac{3}{5}\boldsymbol{e_z}$$

d)

$$\boldsymbol{E} = 2\cos(\omega t - 4y + 3z)\,\boldsymbol{e}_y + \cos(\omega t - 4y + 3z)\,\boldsymbol{e}_z$$

$$\Rightarrow \quad \frac{E_y}{E_z} = \frac{2\cos(\omega t - 4y + 3z)}{\cos(\omega t - 4y + 3z)} = 2$$

E_y ve E_Z bileşenlerinin lineer bir ilişkiye sahip olduğu görülmektedir. Dolayısıyla lineer polarizasyon mevcut.

c) $\vec{E}(z) = e^{-23,1z} \cdot e^{j91,8 \cdot z}\, \vec{e_x} + 3 \cdot e^{-23,1z}\, e^{j(91,8z+\pi/2)}$

$z = 0,3m \Rightarrow (-0,726 + j \cdot 0,655)\, 10^{-3}\, \vec{e_x} + (1,966 + j \cdot 2,177) \cdot 10^{-3}\, \vec{e_y}$ //

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2) a) $\varepsilon' = \varepsilon = \varepsilon_r \cdot \varepsilon_0 = 2\varepsilon_0 \rightarrow \varepsilon_r = 2$

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

$\Rightarrow \dfrac{\varepsilon''}{\varepsilon'} = \dfrac{9,5 \times 10^{-12}}{2 \cdot \frac{1}{36\pi} \cdot 10^{-9}} = 537,212 \times 10^{-3} \cong 0,537$ ✓

Buna göre, herhangi bir yaklaşık ifade kullanmamak uygun olur

$\Rightarrow k_c = \beta + j\alpha = \sqrt{(2\pi\, 3 \cdot 10^9)^2\, 2 \cdot \frac{1}{36\pi} \cdot 10^{-9}\, 4\pi \cdot 10^{-7} + \dots}$

$\overline{\dots\; j\,\underbrace{0,179}_{\downarrow} \cdot 2\pi\, 3 \cdot 10^9\, 4\pi \cdot 10^{-7}} = \underbrace{91,8}_{\beta} + j\, \underbrace{23,1}_{\alpha} = k_c$

$\sigma = \varepsilon'' \omega \cong 0,179$

$\gamma = jk_c$: yayılma sabiti (sadece k_c'yi bulduysanız puan kırmadım.)

k_c : kompleks dalga sayısı ↳ (Bazen birbirlerinin yerine kullanılabiliyorlar, terim olarak)

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

↓

Bileşenlerin arasında 90° faz farkı var ve genlikler farklı. O halde eliptik polarizasyon mevcut

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

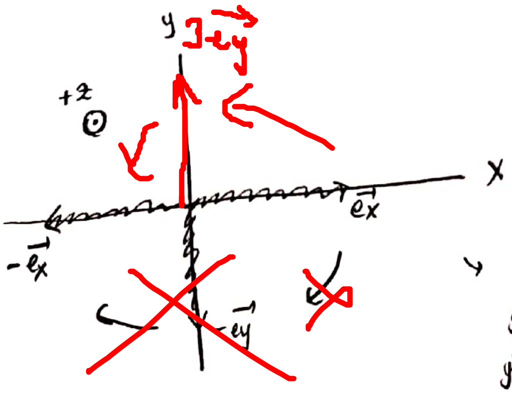
↳ Yayılma yönü : $+z$

At $z = 0$,

$\omega t = 0 \Rightarrow \vec{E}(z,t) = \vec{e_x}$

$\omega t = \pi/2 \Rightarrow \vec{E}(z,t) = 3\vec{e_y}$

$\omega t = \pi \Rightarrow \vec{E}(z,t) = -\vec{e_x}$



↳ ~~Sol~~ Sağ elin başparmağı yayılma yönünü (+z) gösterirken, dört parmak elektrik alanın yönlendiği yönü gösteriyor. O halde "~~Sol~~ Sağ el eliptik polarize". //

CamScanner ile tarandı

3)

Q: Amplitude of electric field and average power density of a wave propogating in non-magnetic lossless media are 12,4 V/m and 1,2 W/m², respectively. Then, what is phase velocity of the wave?

A:

$$\vec{E} = 12{,}4 \cdot e^{+j\vec{k}\vec{r}}\, \vec{n_e} \quad (\vec{n_e} : \text{elektrik alan vektörünün yönü})$$

$$\vec{H} = \frac{12{,}4}{\eta} \cdot e^{+j\vec{k}\vec{r}} \cdot (\vec{n} \times \vec{n_e}) = \frac{12{,}4}{\eta} \cdot e^{+j\cdot\vec{k}\vec{r}}\, \vec{n_h}$$

$$Re\left\{\frac{1}{2}\vec{E}\times\vec{H}^*\right\} = Re\left\{\frac{1}{2}\, 12{,}4 \cdot e^{+j\cdot\vec{k}\cdot\vec{r}}\, \vec{n_e} \times \frac{12{,}4}{\eta} \cdot e^{j\vec{k}\cdot\vec{r}}\, \vec{n_h}\right\}$$

$$= \frac{1}{2\eta} \cdot (12{,}4)^2\, \vec{n}$$

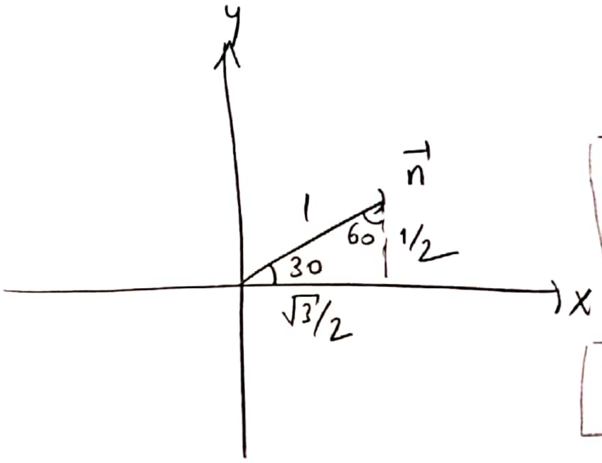
$$\Rightarrow \quad \eta = \frac{12{,}4^2}{2 \times 1{,}2} = 64{,}06 = \sqrt{\frac{\mu_0}{\varepsilon_r \varepsilon_0}} = \frac{1}{\sqrt{\varepsilon_r}} \sqrt{\frac{\mu_0}{\varepsilon_0}}$$

$$\Rightarrow \quad \varepsilon_r = \left(\frac{120\pi}{64{,}06}\right)^2 = 34{,}63$$

$$\Rightarrow \quad v = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{1}{\sqrt{\varepsilon_r}} \cdot c = 0{,}509 \times 10^8 \text{ m/s}$$

4)

a)



$$\boxed{\vec{n} = \frac{\sqrt{3}}{2}\vec{e_x} + \frac{1}{2}\vec{e_y}}$$

$$\boxed{\vec{n}_H = \vec{e_z}}$$

$$\Rightarrow \vec{n}_E = -\vec{n} \times \vec{n}_H$$

$$= -\frac{\sqrt{3}}{2}\vec{e_x} \times \vec{e_z} - \frac{1}{2}\vec{e_y} \times \vec{e_z}$$

$$= \boxed{\frac{\sqrt{3}}{2}\vec{e_y} - \frac{1}{2}\vec{e_x} = \vec{n}_E}$$

$$\vec{E} = E_0 \, e^{+jk\vec{n}\cdot\vec{r}} \cdot \vec{n}_E = 2\, e^{+j(4+j)\left(\frac{\sqrt{3}}{2}x + \frac{1}{2}y\right)} \left(-\frac{1}{2}\vec{e_x} + \frac{\sqrt{3}}{2}\vec{e_y}\right)$$

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

$$+ \sqrt{3}\,\vec{e_y} \cdot e^{-\frac{\sqrt{3}}{2}x - \frac{1}{2}y} \, e^{+j(2\sqrt{3}x + 2y)} \quad //$$

$$\vec{H} = \frac{E_0}{\eta} e^{+jk\vec{n}\cdot\vec{r}} \, \vec{n}_H \quad , \quad \eta = \sqrt{\frac{\mu}{\varepsilon}} = \sqrt{\frac{\mu_0}{\varepsilon + j\frac{\sigma}{\omega}}} = \sqrt{\frac{\mu_0}{\varepsilon_0\left(\varepsilon_r + j\frac{\sigma}{\omega\varepsilon_0}\right)}}$$

$$= \frac{\mu_0}{\sqrt{\varepsilon_r + j\frac{\sigma}{\omega\varepsilon_0}}}$$

$$\varepsilon_r = \frac{Re\{k^2\}}{\omega^2 \varepsilon_0 \mu}$$

$$\sigma = \frac{|Im\{k^2\}|}{\omega\mu}$$

$\Rightarrow \eta = 185{,}7$ [redacted] $46{,}4j$ //

CamScanner ile tarandı

b) $\%10 \longrightarrow 2 \cdot \underbrace{x \cdot 1 \cdot 10}_{\checkmark} = 0,2$

$$e^{-\frac{\sqrt{3}}{2}x - \frac{1}{2}y} = \frac{1}{10}$$

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

$(x,1) \longrightarrow y = 1 \ m$

$$\Rightarrow \frac{\sqrt{3}}{2}x = 1,8 \Rightarrow x = 2,078 \ m$$

//

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

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

$= (0,\cancel{3}69 + j \cdot 0,0139) \cdot (-\vec{e_x}) + (0,0639 + j \cdot 0,0242)\,\vec{e_y}$ //

$0,0369$