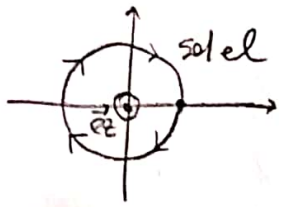
ÖDEV 3

Yiğit Bekfor Güney
040190663

1-) Açısal frekans ω $+z$ yönü
Genlik E_0 Sol el polarize

a) $\vec{n} = \vec{e_z}$



$$\vec{E}(z,t) = E_0 \cos(kz-\omega t)\vec{e_x} - E_0 \sin(kz-\omega t)\vec{e_y}$$

$$\vec{E}(z) = E_0 e^{-jkz}\vec{e_x} + E_0 j e^{-jkz}\vec{e_y}$$

b) $\vec{H}(z,t) = \frac{1}{z}\vec{n}\times\vec{E} = \frac{1}{z}\vec{e_z}\times[E_0\cos(kz-\omega t)\vec{e_x} - E_0\sin(kz-\omega t)\vec{e_y}]$

$$H(z,t) = \frac{E_0}{z}[\cos(kz-\omega t)\vec{e_y} + \sin(kz-\omega t)]$$

$$H(z) = \frac{E_0}{z}[e^{-jkz}\vec{e_y} - je^{-jkz}\vec{e_y}]$$

c) $P(z,t) = \vec{E}(z,t)\times\vec{H}(z,t) = E_0[\cos(kz-\omega t)\vec{e_x} - \sin(kz-\omega t)\vec{e_y}]\times\frac{E_0}{z}[\cos(kz-\omega t)\vec{e_y} + \sin(kz-\omega t)\vec{e_x}]$

$$P(z,t) = \frac{E_0^2}{z}[\cos^2(kz-\omega t)(\vec{e_x}\times\vec{e_y}) - \sin^2(kz-\omega t)(\vec{e_y}\times\vec{e_x})]$$

$$P(z,t) = \frac{E_0^2}{z}\cdot\vec{e_z}$$

2-) Kompli ortam için; $k^2 = 4\pi^2 10^{16}\cdot\frac{4\pi}{12\pi}10^{-16} + j2\pi 10^8\cdot 4\pi\cdot 10^{-9}$

$\sigma = 10^{-2}$

$\varepsilon = 3\varepsilon_0 = \frac{1}{12\pi}\times 10^{-9} =$

$\omega = 2\pi f = 2\pi 10^8$

$\mu = \mu_0 = 4\pi 10^{-7}$

$k^2 = \omega^2\mu\varepsilon + j\omega\mu\sigma$

$k^2 = 13{,}16 + j7{,}9$
$k = 3{,}78 + j1{,}05$ (β, α)

İnternetten karmaşık sayılarda işlem yapabileceğim bir hesap makinesi yardımıyla yaptım.

$|E|(x) = e^{-\alpha x}|E_0| = e^{-4{,}05x}\cdot 10$, $E(0) = 10$, $E(z) = 0{,}172\cdot 10$

Giriş ve çıkış

$P_s(x) = A_1 P_{ort} = 1{,}3\cdot\frac{1}{2}\mathrm{Re}\left\{\frac{|E|^2}{z}\right\}$

$\mathrm{Re}\left\{\frac{1}{2z}\right\} = \frac{1}{2\omega\mu} = \frac{3{,}78}{4\pi\cdot 10^8\cdot 4\pi\cdot 10^{-7}} \simeq 2{,}39\times 10^{-3}$

$P_s(0) - P_s(z) = 2{,}39\times 10^{-3}\cdot(|E|^2(0) - |E|^2(z)) = 3 = 0{,}7W$ → Giriş ve çıkıştaki fark

$P_v = \frac{1}{2}\sigma A\int|E|^2(x)dx$

$= 1{,}5\cdot\frac{e^{-2\alpha k^2}}{-2\alpha}\Big|_0^{\infty} = 1{,}5(-7{,}14\cdot 10^{-3} + 0{,}478) \simeq 0{,}7W$ } Isıya dönüşen güç

Eşitlik sağlandı

Yiğit Bulkan Girsay
040180063

3-) $k^2 = \omega^2 \mu_0 (\quad) + \omega \mu_0 (\quad)$

a) $k^2 = 4\omega^2 \mu_0 \varepsilon_0 \Rightarrow k = \frac{2\omega}{c}$

$\vec{H}(z) = (3\vec{e}_x - 2j\vec{e}_y) \cdot e^{-j2z}$ $\quad k=2$ ise $\boxed{\omega = c}$

$\omega = 3\times10^8$

$z = \frac{\omega \mu_0}{k} = \frac{3\times10^8 \, 4\pi 10^{-7}}{2} \simeq 188,5$

$n = -\vec{e}_z$ için

$E(z) = -z \cdot (\vec{e}_z) \times H(z) = 188,5 e^{-j2z} \vec{e}_z (3\vec{e}_x - 2j\vec{e}_y)$

$E(z) = 60\pi e^{-j2z} (3\vec{e}_y + 2j\vec{e}_x)$

$E(z) = 60\pi \left[2\vec{e}_x \sin(2z + 3\times10^8 t) + \vec{e}_y \sin(2z + 3\times10^8 t) \right]$

e^{-jwt} zaman bağlılığında

b) $k=2$ için $\rightarrow \beta = 2$; kayıpsız ortam

$\lambda = \frac{2\pi}{k} = \pi$ m $\quad v = \frac{\omega}{k} = \frac{3\times10^8}{2} = 1,5\times10^8$ m/s

4-) $\mu = \mu_0$, $\varepsilon = \varepsilon_0$, $\sigma = 0$, $k^2 = \omega^2 4 \varepsilon_0 \mu_0$

$\vec{H}(z,t) = 3\times10^{-3} \cos(kz - \omega t)\vec{e}_x + 4\times10^{-3} \sin(kz - \omega t)\vec{e}_y$

$k = \frac{2\omega}{c}$ $\quad z = \frac{1}{2}\sqrt{\frac{\mu_0}{\varepsilon_0}} = \frac{120\pi}{2} = 60\pi$

$P_{ort} = \frac{1}{2} \frac{|E|^2}{z} = \frac{1}{2} z |H|^2$ $\quad H = \sqrt{(3.10^{-3})^2 + (4.10^{-3})^2} = 5.10^{-3}$ A/m

$P_S = P_{ort} \cdot A_{alan} = \frac{5\pi^2}{2} \cdot 60\pi (5.10^{-3})^2 \simeq 0,185 W = 185 mW$