Gel. EM → Medan listrik (E) → Permitivitas (ε)

$\varepsilon_0 = 8{,}85 \times 10^{-12}$ F/m

→ Medan magnet (M) → Permeabilitas (μ)

$\mu_0 = 4\pi \times 10^{-7}$ H/m

Vakum → Sistem terisolasi dari semua jenis gelombang

Free Space → Sistem tertutup tapi masih dapat dipengaruhi oleh gel. lain

Osilator → Sangat buruk dalam menghantarkan energi

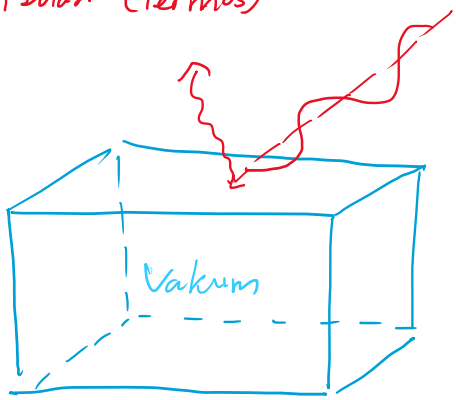
Konduktor → Sangat baik dalam menghantarkan energi

Termodinamika

→ Terbuka

→ Tertutup

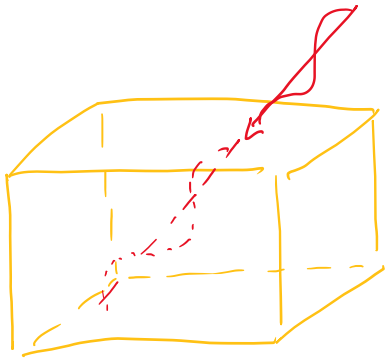
→ Terisolasi (termos)



$\varepsilon_r = 1$

$\mu_r = 1$

$\varepsilon = \varepsilon_r \cdot \varepsilon_0$



$\varepsilon_r = 1$

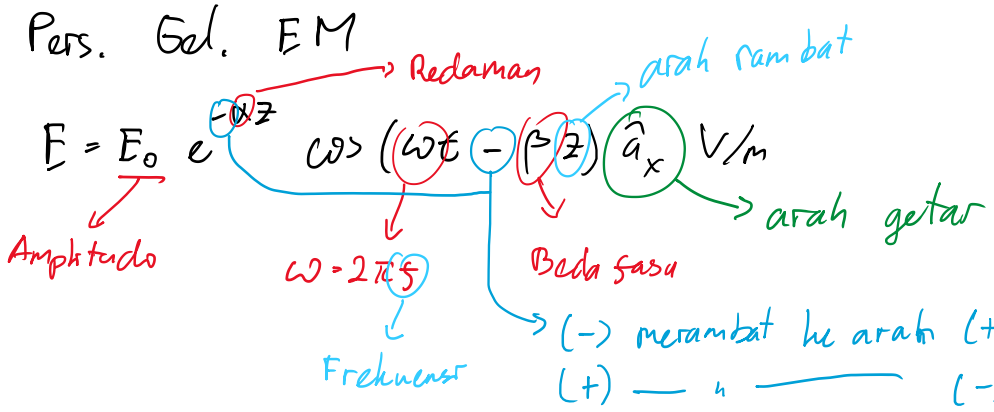
$\mu_r = 1$

$\mu = \mu_r \cdot \mu_0$

Syarat batas → Batas kemampuan gel. EM melalui 2 atau lebih material yg berbeda (Pembiasan)

Gel. Cahaya → Gel. EM melewati kaca atau air

Pers. Gel. EM



$$\beta = \frac{2\pi}{\lambda} \qquad v = \lambda f$$

$$H_0 = \frac{E_0}{|\eta|} \qquad |\eta| = \sqrt{\frac{\mu}{\varepsilon}} = \sqrt{\frac{\mu_0 \mu_r}{\varepsilon_0 \varepsilon_r}} \rightarrow |\eta| = \sqrt{\frac{\mu_0}{\varepsilon_0}} \cdot \sqrt{\frac{\mu_r}{\varepsilon_r}} = 377\sqrt{\frac{\mu_r}{\varepsilon_r}}$$

$\vec{E} \times \vec{H} = \vec{P}$

$\hat{a}_x\ \hat{a}_y\ \hat{a}_z\ \hat{a}_x\ \hat{a}_y$

$-\hat{a}_y \times -\hat{a}_x = \hat{a}_z$

$-(\hat{a}_y \times -\hat{a}_x) = \hat{a}_z$

$(-\hat{a}_z) \neq \hat{a}_z$

$\hat{a}_x \times \hat{a}_y = \hat{a}_z$ $\quad \hat{a}_y \times \hat{a}_x = -\hat{a}_z$

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$-\hat{a}_y \times -\hat{a}_x =$

$-(\hat{a}_y \times -\hat{a}_x) =$

$\hat{a}_y \times \hat{a}_x = -\hat{a}_z$

$\hat{a}_x \times (-\hat{a}_y) = -(\hat{a}_x \times \hat{a}_y) = -\hat{a}_z$

$-\hat{a}_y \times \hat{a}_x = -(\hat{a}_y \times \hat{a}_x) = -(-\hat{a}_z) = \hat{a}_z$

$\lambda = 25$ cm

$E_0 = 100$ V/m

$\alpha = 0$ → kons. redaman

$E = E_0\, e^{-\alpha x} \cos(\omega t - \beta x)\, \hat{a}_z$

$E = 100 \cos(2\pi t \times 10^9 - 25{,}13x)\, \hat{a}_z$

$$v = \frac{1}{\sqrt{\mu \cdot \varepsilon}} = \frac{1}{\sqrt{\mu_0 \cdot \varepsilon_0}} = c = 3 \times 10^8 \text{ m/s}$$

$$v = \lambda f \rightarrow f = \frac{v}{\lambda} = \frac{3 \times 10^8}{25 \times 10^{-2}} = 1{,}2 \times 10^9 \text{ Hz} = 1{,}2 \text{ GHz}$$

$$\beta = \frac{2\pi}{\lambda} = \frac{2\pi}{0{,}25} = 8\pi = 25{,}13 \text{ rad/m}$$

$$T = \frac{1}{f} = \frac{1}{1{,}2 \times 10^9} = 0{,}33 \times 10^{-10} = 0{,}33 \text{ ns}$$

$H_0 = 0{,}25$ A/m $\qquad E_0 = H_0 \cdot 377 = 0{,}25 \cdot 377 = 94{,}25$ V/m

$$-\hat{a}_z \times \hat{a}_x = -(\hat{a}_z \times \hat{a}_x) = -\hat{a}_y$$

$$P_{z,av} = \frac{E_0^2}{2|\eta|} e^{-2\alpha z} \cos\theta_\eta = \frac{E_0^2}{2|\eta|} = \frac{1}{2} E_0 \cdot \frac{E_0}{|\eta|} = \frac{1}{2} \cdot E_0 \cdot H_0$$

H_0

Sudut antara gel. EM dgn gel. redaman

$\alpha = 0$

$f = 500\ MHz = 5 \times 10^8\ Hz$

$\vec{P} : -\hat{a}_y$

$\vec{E} : -\hat{a}_x$

$E_0 = 25\ V/m$

$\omega = 2\pi \cdot f$

$\omega = 2\pi \cdot 5 \times 10^8$

$\omega = \pi \times 10^9\ rad/m$

$$v = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = c = 3 \times 10^8\ m/s$$

$$\lambda = \frac{v}{f} = \frac{3 \times 10^8}{5 \times 10^8} = 0{,}6\ m$$

$$\beta = \frac{2\pi}{\lambda} = \frac{2\pi}{0{,}6} = 10{,}47$$

$$H_0 = \frac{E_0}{|\eta|} = \frac{25}{377} = 0{,}0663\ A/m = 66{,}3\ mA/m$$

$\vec{E} \times \vec{H} = \vec{P}$

$-\hat{a}_x \times \hat{a}_z = -\hat{a}_y$

$-(\hat{a}_x \times \hat{a}_z) = -\hat{a}_y$

$-(-\hat{a}_y) \neq -\hat{a}_y$

$\therefore \vec{H} : -\hat{a}_z$

$$\vec{E} = E_0 e^{\alpha y} \cos(\omega t + \beta y)(-\hat{a}_x)$$

$$\vec{E} = -25 \cos(\pi \times 10^9 t + 10{,}47 y)\ \hat{a}_x\ V/m$$

$$\vec{H} = H_0 e^{\alpha y} \cos(\omega t + \beta y)(-\hat{a}_z)$$

$$\vec{H} = -0{,}0663 \cos(\pi \times 10^9 t + 10{,}47 y)\ \hat{a}_z\ A/m$$

$$\vec{P} = \vec{E} \times \vec{H}$$

$$\vec{P} = P_0 e^{2\alpha y} \cos^2(\omega t + \beta y)(-\hat{a}_y)$$

$$P_0 = E_0 \cdot H_0$$

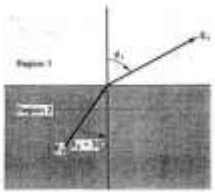
$$\vec{P} = -1{,}66 \cos^2(\pi \times 10^9 t + 10{,}47 y)\ \hat{a}_y\ W/m^2$$

$$P_{av} = \frac{1}{2} E_0 H_0 = 0{,}83\ W/m^2$$

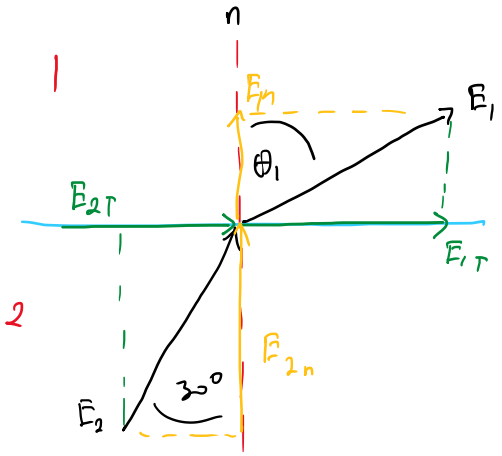
Suatu medan listrik E_2 pada region 2 yang bersifat dielektrik sempurna, memiliki amplitude 10 V/m dan membentuk sudut θ_2 = 30° terhadap sumbu normal. E_2 akan menembus region 1 yang juga bersifat dielektrik sempurna. Tentukan besarnya E_1 dan

$E_2 = 10$ V/m $\varepsilon_1 = 0{,}5\ \varepsilon_2$

$\theta_2 = 30°$



$$|\vec{E}|^2 = \left(\sqrt{E_x^2 + E_y}\right)^2$$



$$E_{1T} = E_{2T} = E \sin 30°$$

$$E_{1T} = 10 \cdot \frac{1}{2}$$

$$E_{1T} = 5 \text{ V/m}$$

$$D_{1N} = D_{2N}$$

$$\varepsilon_1 E_{1N} = \varepsilon_2 E_{2N}$$

$$0{,}5\,\varepsilon_2 \cdot E_{1N} = \varepsilon_2 \cdot E_{2N} \cos 30°$$

$$E_{1N} = 2 \cdot 10 \cdot \frac{1}{2}\sqrt{3}$$

$$E_{1N} = 10\sqrt{3}$$

$$E_1 = \sqrt{E_{1N}^2 + E_{1T}^2} = \sqrt{(10\sqrt{3})^2 + 5^2} = \sqrt{325} = 5\sqrt{13} \text{ V/m}$$

$$\theta_1 = \tan^{-1}\left(\frac{E_{1T}}{E_{1N}}\right)$$

$$\theta_1 = \tan^{-1}\left(\frac{5}{10\sqrt{3}}\right) = 16{,}1°$$