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— ELEKTROMAGNETIKA —

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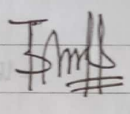
"Saya mengerjakan ujian ini dengan jujur dan mandiri. Jika saya melakukan pelanggaran, maka saya bersedia menerima sanksi."



1) Diketahui $\varepsilon_r = 5{,}14$ $\quad P = 5 \rightarrow$ arah z negatif

$\mu_r = 0{,}99$ $\quad q = 2$

$f = 1\ GHz$

$A = 2 \times 100\ \hat{a_x}\ V/m = 200\ \hat{a_x}\ V/m$

a) • Kecepatan fasa gelombang

$$V_p = \frac{c}{\sqrt{\mu_r \cdot \varepsilon_r}} = \frac{3 \times 10^8}{\sqrt{5{,}14 \times 0{,}99}} = 1{,}297 \times 10^8\ m/s$$

• panjang gelombang

$$\lambda = \frac{2\pi}{\beta} \rightarrow \beta = \frac{\omega}{c}\sqrt{\mu_r \cdot \varepsilon_r}$$

$$= \frac{2\pi f}{c}\sqrt{\mu_r \cdot \varepsilon_r}$$

$$= \frac{2\pi \times 10^9}{3 \times 10^8}\sqrt{0{,}99 \times 5{,}14}$$

$$= \frac{20\pi}{3}\sqrt{0{,}99 \times 5{,}14}$$

$$= 48{,}401\ rad/m$$ //

$$\therefore \lambda = \frac{2\pi}{\beta} = \frac{2 \times 3{,}14}{48{,}401}$$

$$= 0{,}1297\ meter$$ //

• Konstanta propagasi

$\gamma = \alpha + j\beta$ $\quad \therefore \alpha = 0$ karena lossless $\sigma = 0$

$\therefore \beta = 48{,}401$

maka :

$\gamma = \alpha + j\beta$

$= 0 + j\ 48{,}401$ //

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b) Impedansi intrinsik $\rightarrow \bar{\eta} = 377 \sqrt{\frac{\mu_r}{\varepsilon_r}}$

$= 377 \sqrt{\frac{0,99}{5,9}}$

$= 161,922\ \Omega$ //

c) Persamaan vektor medan listrik

$\vec{E} = A \cos(\omega t + \beta z)\ \hat{a_x}\ (V/m)$

$\vec{E} = 2.100 \cos(2\pi \times 10^9\ t + 48,401\ z)\ \hat{a_x}\ (V/m)$

$\vec{E} = 200 \cos(2\pi \times 10^9\ t + 48,401\ z)\ \hat{a_x}\ (V/m)$ //

d) Persamaan vektor medan magnet

$\vec{H} = \frac{A}{\bar{\eta}} \cos(\omega t + \beta z)\ (-\hat{a_y})\ (A/m)$

$\vec{H} = \frac{200}{161,922} \cos(2\pi \times 10^9\ t + 48,401\ z)\ (-\hat{a_y})\ (A/m)$

$\vec{H} = -1,239 \cos(2\pi \times 10^9\ t + 48,401\ z)\ \hat{a_y}\ (A/m)$ //

e) Persamaan vektor pointing

$\vec{P} = \frac{E_{x0}^2}{2|\bar{\eta}|} e^{-2\alpha z} \left(\cos\theta_n + \cos(2\omega t + 2\beta z) + \theta\right) - \hat{a_z}\ watt/m^2$

$\vec{P} = \frac{200^2}{2(161,922)} e^{0z} \left(\cos 0 + \cos\left(2(2\pi \times 10^9)t + 2(48,401)z\right)\right) - \hat{a_z}\ watt/m^2$

$\vec{P} = -123,899\ (1 + \cos(4\pi \times 10^9\ t + 96,802\ z))\ \hat{a_z}$ // $watt/m^2$

f) Rapat daya rata-rata

$P_{AV} = \frac{1}{2} \frac{E_0^2}{377} \sqrt{\frac{\varepsilon_r}{\mu_r}}$

$= \frac{1}{2} \frac{200^2}{377} \sqrt{\frac{5,9}{0,99}}$

$= 123,899\ watt/m^2$ //

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(2.) Diketahui bidang YZ → $\bar{n} = \hat{a}_x$

$\vec{D_1} = \hat{a}_x - 8\,\hat{a}_y + 4\,\hat{a}_z$ C/m²

$\vec{H_2} = 10\,\hat{a}_x + 5\,\hat{a}_y - 2\,\hat{a}_z$ A/m

$\varepsilon_2 = 4\varepsilon_0$

$\mu_2 = \mu_0$

$\rho_s = 2$ C/m²

$\vec{J_s} = 5\,\hat{a}_z$ A/m²

- $\bar{n} \cdot (\vec{D_1} - \vec{D_2}) = \rho_s$

$\hat{a}_x \cdot \left[(a_x - 8\,\hat{a}_y + 4\,\hat{a}_z) - (D_{2x}\,\hat{a}_x + D_{2y}\,\hat{a}_y + D_{2z}\,\hat{a}_z)\right] = 2$

$\hat{a}_x \cdot \left[(1 - D_{2x})\hat{a}_x + (-8 - D_{2y})\,\hat{a}_y + (4 - D_{2z})\hat{a}_z\right] = 2$

$\therefore 1 - D_{2x} = 2$

$\boxed{\vec{D_{2x}} = -1\ \text{C/m}^2}$

$\therefore \vec{E_{2x}} = \frac{D_{2x}}{\varepsilon} = -\frac{1}{\varepsilon_0}$ V/m

- $\bar{n} \times (\vec{E_1} - \vec{E_2}) = 0$

$\hat{a}_x \times \left[\left(\frac{D_{1x}}{\varepsilon_0}\hat{a}_x + \frac{D_{1y}}{\varepsilon_0}\hat{a}_y + \frac{D_{1z}}{\varepsilon_0}\hat{a}_z\right) - (E_{2x}\,\hat{a}_x + E_{2y}\,\hat{a}_y + E_{2z}\,\hat{a}_z)\right] = 0$

$\hat{a}_x \times \left[\left(\frac{1}{\varepsilon_0} - E_{2x}\right)\hat{a}_x + \left(-\frac{8}{\varepsilon_0} - E_{2y}\right)\hat{a}_y + \left(\frac{4}{\varepsilon_0} - E_{2z}\right)\hat{a}_z\right] = 0$

$\therefore -\frac{8}{\varepsilon_0} - E_{2y}\,\hat{a}_z = 0$

$\vec{E_{2y}} = -\frac{8}{\varepsilon_0}$ V/m

$\vec{D_{2y}} = -8$ C/m²

$\therefore \frac{4}{\varepsilon_0} - E_{2z}(-\hat{a}_y) = 0$

$\vec{E_{2z}} = \frac{4}{\varepsilon_0}$ V/m

$\vec{D_{2z}} = 4$ C/m²

- $\bar{n} \cdot (\vec{B_1} - \vec{B_2}) = 0$

$\hat{a}_x \cdot \left[(B_{1x}\,\hat{a}_x + B_{1y}\,\hat{a}_y + B_{1z}\,\hat{a}_z) - (\mu_2 H_{2x}\,\hat{a}_x + \mu_2 H_{2y}\,\hat{a}_y + \mu_2 H_{2z}\,\hat{a}_z)\right] = 0$

$\hat{a}_x \cdot \left[(B_{1x} - \mu_2 H_{2x})\,\hat{a}_x + (B_{1y} - \mu_2 H_{2y})\,\hat{a}_y + (B_{1z} - \mu_2 H_{2z})\,\hat{a}_z\right] = 0$

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$\therefore B_{1x} - \mu_2 H_{2x} = 0$

$B_{1x} - 10\,\mu_0 = 0$

$\overrightarrow{B_{1x}} = 10\,\mu_0\ T$ //

• $\vec{n} \times (\vec{H_1} - \vec{H_2}) = \vec{J_s}$

$\hat{a_x} \times [(H_{1x}\,\hat{a_x} + H_{1y}\,\hat{a_y} + H_{1z}\,\hat{a_z}) - (10\,\hat{a_x} + 5\,\hat{a_y} - 2\,\hat{a_z})] = 5\,\hat{a_z}$

$\hat{a_x} \times [(H_{1x} - 10)\,\hat{a_x} + (H_{1y} - 5)\,\hat{a_y} + (H_{1z} + 2)\,\hat{a_z}] = 5\,\hat{a_z}$

$\therefore H_{1y} - 5\,(\hat{a_z}) = 5$

$\overrightarrow{H_{1y}} = 5 + 5$

$\boxed{\overrightarrow{H_{1y}} = 10\ A/m}$

$\overrightarrow{B_{1y}} = \mu \cdot H$

$\overrightarrow{B_{1y}} = 10\,\mu_0\ T$ //

$\therefore H_{1z} + 2\,(-\hat{a_y}) = 0$

$\boxed{\overrightarrow{H_{1z}} = -2\ A/m}$

$\overrightarrow{B_{1z}} = \mu \cdot H$

$\overrightarrow{B_{1z}} = -2\,\mu_0\ T$ //

$\therefore \overrightarrow{D_2} = -\hat{a_x} - 8\,\hat{a_y} + 4\,\hat{a_z}\ \ C/m^2$

$\overrightarrow{B_1} = 10\,\mu_0\,\hat{a_x} + 10\,\mu_0\,\hat{a_y} - 2\,\mu_0\,\hat{a_z}$

$= \mu_0\,(10\,\hat{a_x} + 10\,\hat{a_y} - 2\,\hat{a_z})$ Tesla //