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P8-22 a). $k_x = 6$, $k_z = 8$

$k = \sqrt{6^2 + 8^2} = 10$ rad/m

$\lambda = 2\pi / k = 0.628$ m

$f = \frac{c}{\lambda} = 4.78 \times 10^8$ Hz

$\omega = kc = 3 \times 10^9$ rad/s

b). $\vec{E} = \hat{a}_y 10 \cos(3\times10^9 t - 6x - 8z)$

$\vec{H} = \frac{1}{\eta_0} \hat{a}_{ni} \times \vec{E}$

$= \left(-\hat{a}_x \frac{1}{15\pi} + \hat{a}_z \frac{1}{20\pi}\right) e^{-j(6x+8z)}$

$\vec{H} = \left(-\hat{a}_x \frac{1}{15\pi} + \hat{a}_z \frac{1}{20\pi}\right) \cos(3\times10^9 t - 6x - 8z)$

c). $\cos\theta_i = \vec{a_{ni}} \cdot \vec{a_z} = 0.8$

$\theta_i = 36.9°$

d). $\vec{E_r} = -\hat{a}_y 10 e^{-j(6x-8z)}$

$\vec{H_r} = \frac{1}{\eta_0} \vec{a_{nr}} \times \vec{E_r}$

$= -\left(\hat{a}_x \frac{1}{15\pi} + \hat{a}_z \frac{1}{20\pi}\right) e^{-j(6x-8z)}$

e). $\vec{E_1} = \vec{E_i} + \vec{E_r} = -\hat{a}_y j 20 e^{-j6x} \sin 8z$

$\vec{H_1} = \vec{H_i} + \vec{H_r} = -\left(\hat{a}_x \frac{2}{15\pi} \cos 8z + \hat{a}_z \frac{j}{10\pi} \sin 8z\right) e^{-j6x}$

P8-37 a). $\sin\theta_c = \sqrt{\frac{\epsilon_2}{\epsilon_1}} \Rightarrow \sin\theta_t = \sqrt{\frac{\epsilon_1}{\epsilon_2}} \sin\theta_i$

$\cos\theta_t = -j\sqrt{\frac{\epsilon_1}{\epsilon_2}\sin^2\theta_i - 1}$

$\vec{E_t} = \hat{a}_y E_{t0} e^{-\alpha z} e^{-j\beta x}$

$\vec{H_t} = \frac{E_{t0}}{\eta_2}\left(\hat{a}_x j\alpha + \hat{a}_z \sqrt{\frac{\epsilon_1}{\epsilon_2}} \sin\theta\right) e^{-\alpha z} e^{-j\beta x}$

where $\beta = \beta_2 \sqrt{\frac{\epsilon_1}{\epsilon_2}} \sin\theta_i$

$\alpha = \beta_2 \sqrt{\frac{\epsilon_1}{\epsilon_2}\sin^2\theta_i - 1}$

$E_{t0} = \frac{2\eta_2 \cos\theta_i E_{i0}}{\eta_2 \cos\theta_i - j\eta_1\sqrt{\frac{\epsilon_1}{\epsilon_2}\sin^2\theta_i - 1}}$

b). $P_{avg} = \frac{1}{2} Re(\vec{E} \times \vec{H}^*) = 0.$

P8-40. $\tau_1 = \frac{2\eta_2}{\eta_2 + \eta_0}$

$\frac{(P_{avg})_{t1}}{(P_{avg})_i} = \frac{\eta_0}{\eta_2}\tau_1^2 = \frac{4\eta_0\eta_2}{(\eta_2+\eta_0)^2}$

$\theta_i = 45°$ $\theta_c = 30°$

$\tau_2 = \frac{2\eta_0}{\eta_2 + \eta_0}$

$\frac{(P_{avg})_o}{(P_{avg})_{t1}} = \frac{\eta_2}{\eta_0}\tau_2^2 = \frac{4\eta_0\eta_2}{(\eta_0+\eta_2)^2}$

$\frac{(P_{avg})_o}{(P_{avg})_i} = \left(\frac{4\eta_0\eta_2}{(\eta_2+\eta_0)^2}\right)^2 = 0.79$

P8-45 $\Gamma_\perp = \dfrac{\eta_2\cos\theta_i - \eta_1\cos\theta_t}{\eta_2\cos\theta_i + \eta_1\cos\theta_i}$

$$= \frac{\sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}}\cos\theta_i - \cos\theta_t}{\sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}}\cos\theta_i + \cos\theta_t}$$

$$= \frac{\sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}}\cos\theta_i - \sqrt{1-\frac{\epsilon_{r1}}{\epsilon_{r2}}\sin^2\theta_i}}{\sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}}\cos\theta_i + \sqrt{1-\frac{\epsilon_{r1}}{\epsilon_{r2}}\sin^2\theta_i}}$$

Similarily $\tau_\perp = \dfrac{2\sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}}\cos\theta_i}{\sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}}\cos\theta_i + \sqrt{1-\frac{\epsilon_{r1}}{\epsilon_{r2}}\sin^2\theta_i}}$

$$\Gamma_{\parallel} = \frac{\sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}}\sqrt{1-\left(\frac{\epsilon_{r1}}{\epsilon_{r2}}\right)\sin^2\theta_i} - \cos\theta_i}{\sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}}\sqrt{1-\frac{\epsilon_{r1}}{\epsilon_{r2}}\sin^2\theta_i} + \cos\theta_i}$$

$$\tau_{\parallel} = \frac{2\sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}}\cos\theta_i.}{\sqrt{\frac{\epsilon_{r1}}{\epsilon_{r2}}}\sqrt{1-\frac{\epsilon_{r1}}{\epsilon_{r2}}\sin^2\theta_i} + \cos\theta_i}$$