7.

Region 1 | Region 2

$\epsilon'_{r_1}, \epsilon''_1$ | $\epsilon'_{r_2}, \epsilon''_2$

μ_{r_1} | μ_{r_2}.

$$\epsilon = \epsilon'_r - j\epsilon'' = \epsilon'_r\left(1 - j\frac{\epsilon''}{\epsilon'_r}\right) = \epsilon'_r(1 - j\tan\delta)$$

Given. $\epsilon''_1 = \epsilon''_2 = 0$. $\Rightarrow \tan\delta_1 = \tan\delta_2 = 0$.

$\Rightarrow \sigma_1 = \sigma_2 = 0$

$\Rightarrow$ lossless.

$$|\Gamma|^2 = 0.2$$

$$\Rightarrow |\Gamma| = \pm 0.44$$

$$\Gamma = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} = \frac{\sqrt{\frac{\mu_2}{\epsilon_2}} - \sqrt{\frac{\mu_1}{\epsilon_1}}}{\sqrt{\frac{\mu_2}{\epsilon_2}} + \sqrt{\frac{\mu_1}{\epsilon_1}}} = \frac{\frac{1}{\mu_2} - \frac{1}{\mu_1}}{\frac{1}{\mu_2} + \frac{1}{\mu_1}}$$

$\left[\because \epsilon'_{r_1} = \mu_{r_1}^3 \text{ \& } \epsilon'_{r_2} = \mu_{r_2}^3\right]$.

$\left[\text{let } \mu_{r_1} = \mu_1 \text{ \& } \mu_{r_2} = \mu_2\right]$.

$$= \frac{\mu_1 - \mu_2}{\mu_1 + \mu_2} = 0.44$$

$$\Rightarrow \frac{\mu_1}{\mu_2} = \frac{1.44}{0.56} = 2.5714$$

$\Rightarrow \epsilon'_{r2}/\epsilon'_{r_1} = 0.058$, similarly for $\Gamma = -0.44$

$\Rightarrow \epsilon'_{r_2}/\epsilon'_{r_1} = 17$

8.

(a) Since $\alpha = 0$ & $\beta \neq \omega/c$, the medium is not free space but a lossless medium.

$\beta = 0.8$, $\omega = 2\pi \times 10^7$, $\mu = \mu_0$ (nonmagnetic)

$\epsilon = \epsilon_0 \epsilon_r$.

$$\beta = \omega\sqrt{\mu\epsilon} = \omega\sqrt{\mu_0\epsilon_0\epsilon_r} = \frac{\omega}{c}\sqrt{\epsilon_r}$$

(or)

$$\sqrt{\epsilon_r} = \frac{\beta c}{\omega} = \frac{0.8\,(3\times10^8)}{2\pi\times10^7} = 12/\pi.$$

$\epsilon_r = 14.59$

$$\eta = \sqrt{\frac{\mu}{\epsilon}} = \sqrt{\frac{\mu_0}{\epsilon_0\epsilon_r}} = \frac{120\pi}{\sqrt{\epsilon_r}} = 120\pi \cdot \frac{\pi}{12} = 10\pi^2$$

$= 98.7\ \Omega.$

(b) $$P = E \times H = \frac{E_0^2}{\eta}\sin^2(\omega t - \beta x)\,a_x.$$

$$P_{ave} = \frac{1}{T}\int_0^T P\,.dt = \frac{E_0^2}{2\eta}\,a_x = \frac{16}{2\times10\pi^2}\,a_x$$

$= 81\,a_x\ mW/m^2.$

(c) on plane $2x + y = 5$

$$a_n = \frac{2a_x + a_y}{\sqrt{5}}$$

Hence the total power is

$$P_{total} = \int P_{ave}\cdot ds = P_{ave}\cdot S\,a_n.$$

$$= (81\times10^{-3})\,a_x \cdot (100\times10^{-4})\left[\frac{2a_x + a_y}{\sqrt{5}}\right]$$

$$= \frac{162\times10^{-5}}{\sqrt{5}} = 724.5\ \mu W.$$