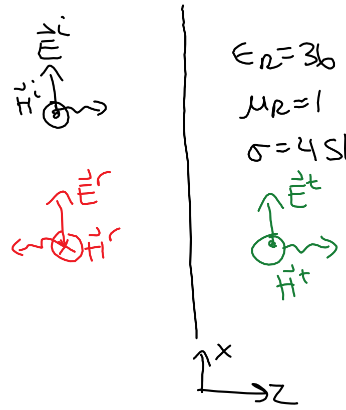
Transmission & Reflection Examples

Ex 1

(1) $\epsilon_R = 7$, $\mu_R = 1$, $\sigma = 0$

(2) $\epsilon_R = 36$, $\mu_R = 1$, $\sigma = 4\ S/m$



- $f = 3\,GHz$
- $E^{inc} \to 10\ V/m$
  - $\to \vec{a}_x$
  - $\to$ propagating in z

Find: α, β, η

T, Γ

$\vec{E}^i, \vec{H}^i;\ \vec{E}^r, \vec{H}^r;\ \vec{E}^t, \vec{H}^t$

$$T = \frac{2\eta_2}{\eta_2 + \eta_1} \qquad \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} = \Gamma$$

(1) $\alpha = 0$; $\beta_1 = 166.2\ Rad/m$; $\eta_1 = 142.5$

(2) $\alpha = 119.72\ Np/m$; $\beta_2 = 395.7\ Rad/m$; $\eta_2 = 57.3\angle 0.29\,Rad$

$$\Gamma = \frac{57.3\angle 0.29 - 142.5}{57.3\angle 0.29 + 142.5} = 0.45\angle 0.9\pi$$

$$T = \frac{2(57.3\angle 0.29)}{57.3\angle 0.29 + 142.5} = 0.58\angle 0.21$$

$$\vec{E}^i(z,t) = 10\cos(6\pi\times 10^9 t - 166.2z)\vec{a}_x$$

$$\vec{H}^i(z,t) = \frac{10}{142.5}\cos(6\pi\times 10^9 t - 166.2z)\vec{a}_y$$

$$\vec{E}^r(z,t) = |\Gamma| E^{inc}\cos(\omega t + \beta_1 z + \theta_\Gamma)$$

$$= 4.5\cos(6\pi\times 10^9 t + 166.2z + 0.9\pi)\vec{a}_x$$

$$\vec{H}^r(z,t) = -\frac{4.5}{142.5}\cos(6\pi\times 10^9 t + 166.2z + 0.9\pi)\vec{a}_y$$

$$\Gamma = |\Gamma| e^{j\theta_\Gamma}$$

$$E_s = E_1 |\Gamma| e^{j\theta_\Gamma} e^{j\beta z}$$

$$\vec{E}^t(z,t) = |T| E^{inc} e^{-\alpha_2 z}\cos(\omega t - \beta_2 z + \theta_T)\vec{a}_x$$

$$= 5.8 e^{-119.72z}\cos(6\pi\times 10^9 t - 395.7z + 0.21)\vec{a}_x$$

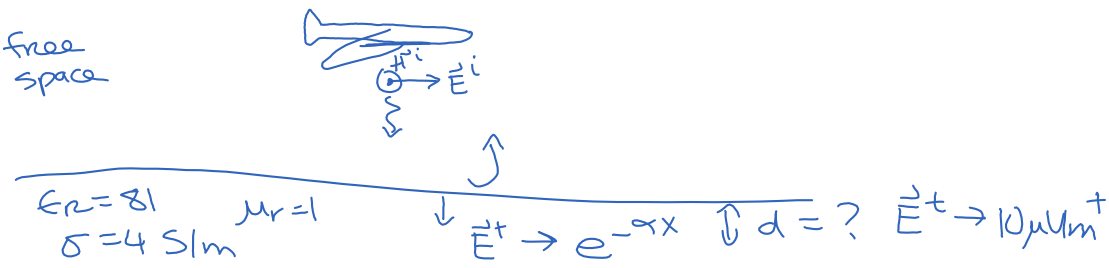
$$\vec{H}^t(z,t) = \frac{|T| E^{inc}}{|\eta_2|} e^{-\alpha_2 z}\cos(\omega t - \beta_2 z + \underline{\theta_T - \theta_\eta})\vec{a}_y$$

$$= \frac{5.8}{57.3} e^{-119.72z}\cos(6\pi\times 10^9 t - 395.7z + \underbrace{0.21 - 0.29}_{-0.08})\vec{a}_y$$

Ex 2 Consider a plane flying over the surface of the ocean & transmitting a 1 MHz signal using a long wire antenna.

a) Assuming UPW with $E^{inc} = 1\ kV/m$ at $x = 0$. If submarine's

Receiver requires minimum signal 10 μV/m, what is max depth of sub for effective communication?



$$\frac{\sigma}{\omega \epsilon} >> 1$$