Continued from Reflection & Refraction of EMW
UG-II

Case II:- When E is parallel to the plane of incidence. In this case the continuity of the tangential component of electric field and magnetic field at the interface requires that

$$E_{oi}\cos\theta_i + E_{or}\cos\theta_i = E_{ot}\cos\theta_t \longrightarrow (1)$$

and

$$H_{oi} - H_{or} = H_{ot}$$

or $\sqrt{\frac{\epsilon_1}{\mu_1}}E_{oi} - \sqrt{\frac{\epsilon_1}{\mu_1}}E_{or} = \sqrt{\frac{\epsilon_2}{\mu_2}}E_{ot}$ ⟶ (2)

putting the value of E_{ot} from (2) in (1) we have

$$\left(\frac{E_{or}}{E_{oi}}\right)_p = \frac{\cos\theta_t - \frac{k_2}{\omega\mu_2}\sqrt{\frac{\mu_1}{\epsilon_1}}\cos\theta_i}{\cos\theta_t + \frac{k_2}{\omega\mu_2}\sqrt{\frac{\mu_1}{\epsilon_1}}\cos\theta_i} \longrightarrow (3)$$

and Similarly eq^n (1) & (2) are solved for E_{or} & E_{oi}, we have

$$\left(\frac{E_{ot}}{E_{oi}}\right)_p = \frac{2\cos\theta_i}{\cos\theta_t + \frac{k^2}{\omega\mu_2}\sqrt{\frac{\mu_1}{\epsilon_1}}\cos\theta_i} \longrightarrow (4)$$

If the medium-2 is a good conductor i.e $\sigma_2 \gg \omega\epsilon_2$ & $\cos\theta_t \approx 1$

and $k_2 = \alpha_2 + j\beta_2 \approx \sqrt{\left(\frac{\omega\mu_2\sigma_2}{2}\right)}(1+j)$

$$\left(\frac{E_{or}}{E_{oi}}\right)_p = \frac{\cos\theta_t - (1+j)\left(\frac{\mu_1\sigma_2}{2\omega\mu_2\epsilon_1}\right)\cos\theta_t}{\cos\theta_t + (1+j)\sqrt{\left(\frac{\mu_1\sigma_2}{2\omega\mu_2\epsilon_1}\right)}\cos\theta_t} \longrightarrow (5)$$

and $$\left(\frac{E_{ot}}{E_{oi}}\right)_p = -\frac{2\cos\theta_t}{\cos\theta_t + (1+j)\sqrt{\left(\frac{\mu_1\sigma_2}{2\omega\mu_2\epsilon_1}\right)}\cos\theta_i}$$

⟶ (6)

when $\sigma_2 \gg \omega\epsilon_1$ then

$$\left(\frac{E_{or}}{E_{oi}}\right)_p \simeq -\left[1 - 2(1-j)\sqrt{\left(\frac{\omega\mu_2\epsilon_1}{2\mu_1\sigma_2}\right)}\cdot\frac{1}{\cos\theta_t}\right] \longrightarrow (7)$$

and $$\left(\frac{E_{ot}}{E_{oi}}\right)_p \simeq (1-j)\sqrt{\left(\frac{2\omega\mu_2\epsilon_1}{\mu_1\sigma_2}\right)}\left[1 - (1-j)\sqrt{\frac{\omega\mu_2\epsilon_1}{2\mu_1\sigma_2}}\right]$$

⟶ (8)

Eq^n (7) & (8) show that

$$\left(\frac{E_{or}}{E_{oi}}\right)_p \simeq -1 \longrightarrow (9)$$

and $$\left(\frac{E_{ot}}{E_{oi}}\right)_p \simeq 0 \longrightarrow (10)$$

These eq^n show that reflected wave is approximately π radian out-of-phase with incident wave and the transmitted wave is approximately in phase with incident wave.