CLASSICAL ELECTRODYNAMICS II

Homework Set 6

October 17, 2014

1. A plane polarized electromagnetic wave $\mathbf{E} = \mathbf{E}_i \, \mathrm{e}^{\mathrm{i}\mathbf{k}\cdot\mathbf{r} - \mathrm{i}\omega t}$ is incident normally on a flat uniform sheet of an *excellent* conductor ($\sigma \gg \omega\epsilon_0$) having a thickness D. Assuming that in space and in the conducting sheet $\mu/\mu_0 = \epsilon/\epsilon_0 = 1$, discuss the reflection and transmission of the incident wave.

   Show that the amplitudes of the reflected and transmitted waves, correct to first order in $(\epsilon_0\omega/\sigma)^{1/2}$, are:

$$\frac{E_r}{E_i} = \frac{-(1 - \mathrm{e}^{-2\lambda})}{(1 - \mathrm{e}^{-2\lambda}) + \gamma(1 + \mathrm{e}^{-2\lambda})}$$

$$\frac{E_t}{E_i} = \frac{2\gamma \mathrm{e}^{-\lambda}}{(1 - \mathrm{e}^{-2\lambda}) + \gamma(1 + \mathrm{e}^{-2\lambda})}$$

   where

$$\gamma = \sqrt{\frac{2\epsilon_0\omega}{\sigma}} \, (1 - \mathrm{i}) = \frac{\omega\delta}{c} \, (1 - \mathrm{i}) \, ,$$

$$\lambda = (1 - \mathrm{i}) \, D/\delta \, ,$$

   and $\delta = \sqrt{2/\omega\mu\sigma}$ is the penetration depth.