

CLASSICAL ELECTRODYNAMICS II

Homework Set 3

February 16, 2018

1. Consider a material in which the half-space with $z > 0$ is filled with a medium with permeability μ' and dielectric constant ϵ' , and the half-space with $z < 0$ is filled with a medium with permeability μ and dielectric constant ϵ . A electromagnetic wave with electric field,

$$\mathbf{E} = \mathbf{E}_0 e^{i(\mathbf{k}\cdot\mathbf{r}-\omega t)} ,$$

is incident on the interface at $z = 0$ between the two dielectrics. Consider the case where \mathbf{E} is parallel to the plane of incidence. Then, starting with the boundary conditions on the fields as derived in class, derive expressions for the ratios E'_0/E_0 and E''_0/E_0 , where E'_0 is the amplitude of the electric field of the transmitted wave and E''_0 is the amplitude of electric field of the reflected wave.

2. The most general homogeneous plane wave propagating in the direction \mathbf{k} may be represented as a superposition of two circularly polarized waves:

$$\mathbf{E}(\mathbf{r}, t) = (\hat{\epsilon}_+ E_+ + \hat{\epsilon}_- E_-) e^{i(\mathbf{k}\cdot\mathbf{r}-\omega t)} ,$$

where E_+ and E_- are complex amplitudes. Show that if $E_-/E_+ = r e^{i\alpha}$, where r and α are real then the \mathbf{E} vector traces out an ellipse with ratio of semimajor axis to semiminor axis, $(r + 1)/(r - 1)$, and the axes of the ellipse are rotated by an angle $\alpha/2$ relative to $\hat{\epsilon}_1$ and $\hat{\epsilon}_2$. For convenience, assume that $r > 1$.