Spring_2018

Physics 8110 - Electromagnetic Theory II

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Assignment #3

(due to Monday, Feb. 26, 2018)

1. Kramers-Kronig relations applied to conductive medium:

   Problem 7.23, Jackson textbook (page 348).

   (30 Points)

2. The index of refraction of diamond is $n_2 = 2.42$.

a) Construct a graph that shows the perpendicular and parallel reflected amplitudes as function of angle of incidence for an air -diamond ($n_1 = 1.0$) interface.

b) Construct a similar graph for the perpendicular and parallel reflectance as function of angle of incidence.

c) Calculate the Brewster angle for the air -diamond interface.

d) Calculate the "crossover" angle, at which the reflected and transmitted amplitudes are equal.

Assume ($\mu_1 = \mu_2 = \mu_0$)

(30 Points)

3. The phenomenon that the permittivity ε changes as function of frequency is called dispersion. By extension, whenever the speed of a wave depends on its frequency, the supporting medium is called dispersive! Shallow water ($d < \lambda$) is nondispersive; the waves travel at a speed that is proportional to the square root of the depth.

   Show that the wave velocity v is twice the group velocity $v_g = d\omega/dk$.

(20 Points)

4. Assuming negligible damping ($\gamma_j = 0$), calculate the group velocity ($v_g = d\omega/dk$) of the waves described by $\vec{E}(z,t) = \vec{E}_0 \cdot e^{-\kappa \cdot z} \cdot e^{i(k \cdot z - w \cdot t)}$,

   where $\alpha = 2 \cdot \kappa$ is the absorption coefficient, $k = n \cdot \omega / c$ the wave vector and ε the complex dielectric function $\varepsilon = 1 + \frac{N \cdot q^2}{2 \cdot m \cdot \varepsilon_o} \sum_j \frac{f_j}{w_j^2 - w^2 - i \cdot \gamma_j \cdot w}$

   Show that $v_g < c$, even when $v > c$.

(20 Points)