PHY103 Problem Set # 13 Date: Nov. 05, 2016 [RCB/Krishnacharya]

1. The index of refraction of diamond is 2.42. Construct a graph showing the ration of E_{oT}/E_{ol} and E_{oR}/E_{ol} as a function of angle if incidence for the air/diamond interface. (Assume $\mu_1 = \mu_2 = \mu_0$) . In particular calculate (a) the amplitude at normal incidence, (b) Brewester's angle, and "crossover angle, at which the reflected and transmitted amplitudes are equal.

2. (a) Show that the skin depth in poor conductor ($\sigma \ll \omega\varepsilon$) is $(2/\sigma)(\varepsilon/\mu)^{1/2}$ (independent of frequency). Find the skin depth (in meters) for pure water.
   (for water $\varepsilon_r = 80.1$, $\chi_m = -9.0\times10^{-6}$, and $\rho = 2.5 \times 10^5 \,\Omega m$)
   (b) Show that the skin depth in a good conductor ($\sigma \gg \omega\varepsilon$) is $\lambda/2\pi$ (where λ is the wavelength in the conductor). Find the skin depth (in nanometers) for a typical metal ($\sigma \sim 10^7 \,(\Omega m)^{-1}$) in the visible range ($\omega \sim 10^{15}/s$), assuming $\varepsilon \sim \varepsilon_0$ and $\mu \sim \mu_0$. Why are metals opaque?
   (c) Show that in a good conductor the magnetic field lags the electric field by 45^0, and find the ration of their amplitudes. Foe a numerical example, use the typical metal of part (b) above.

3. Calculate the time averaged energy density of an electromagnetic plane wave in a conducting medium. Show that the magnetic contributions always dominates.