Phys 3330 Electricity & Magnetism II
Spring 2019
Assignment #10 - due Wednesday April 10h 2019

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1. (This problem is mathematically identical to the quantum mechanical problem of a particle of kinetic energy E which passes through a region of space where the potential energy is V, with E>V. You might want to review your QM notes to help solve this problem.)

   Light is initially traveling in a medium of refractive index n_1 when it is incident normally on a substrate of refractive index n_3 which is coated with a thin film of a material whose refractive index is n_2. Let $k=2\pi/\lambda$, where λ is the wavelength of the light ***in the film***.

   a. Set up the boundary conditions for the electric and magnetic fields at the two boundaries (z=0 and z=d). You can assume that ω is the same in all three materials. Solve for the amplitudes of the electric fields of both the reflected (E_2) and transmitted (E_5) waves. (Maple can be a big help here, using the solve() function.)

   b. Set $d = \frac{1}{4}\lambda$ and solve for the reflection coefficient ($\langle S_2\rangle/\langle S_1\rangle$). Under what condition is there no reflected wave? (This is the basis of anti-reflection coatings on lenses.)

   c. Let d be a variable again, but set $n_3 = n_1$ to simulate a soap bubble with air (n=1) both inside and outside the film. What value(s) of d give a maximum in the reflection coefficient, and what value(s) give a minimum?