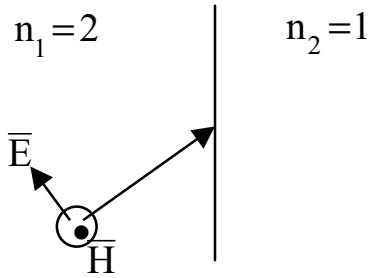
Test 1 (2000.3.30)

Prob1.(55)

A plane EM wave having parallel(TM) polarization is incident on a lossless dielectric interface as shown below.

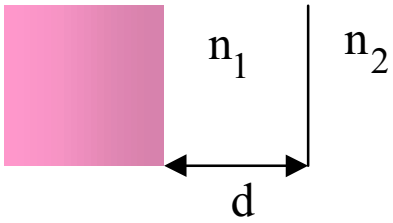


(a)(10) Assume θ is less than the critical angle for the total internal reflection Sketch the reflected EM wave. Make sure the directions for E-and H-field are correctly given.

(b)(10) Now the incident angle is 45 deg. and the incident EM wave has wavelength of 1 μm in vacuum What is the z-component of the k-vector in the medium located on the right side? Give a numerical answer with an appropriate unit.

(c)(15) For the conditions given in (b), what is the reflection coefficient Γ? Derive its expression first and then give a numerical answer.

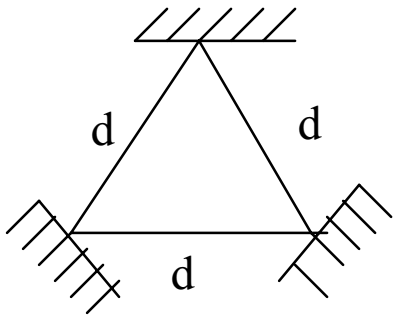
(d)(10) A waveguide is formed by placing a sheet of perfectly conducting metal in parallel with the dielectric interface as show. All the conditions are still the same as in (b). Derive an expression for k_z of the fundamental guided mode. Give your answer in terms of Γ determined in (c) and other symbols given in (c) and other symbols given in this problem as well as constants.



(e) (10) Sketch the photon distribution for the 2nd lowest mode in the waveguide given in (d).

Prob. 2 (45)

A ring interferometer is made with three perfectly reflecting metallic mirrors located in vacuum as shown below.



(a) (10) If light is somehow injected into the interferometer, resonance is only for light when certain frequencies. Determine the resonance condition on the frequency, f. Give your answer in terms of c, the speed of light in vacuum, d, the mirror separation and other constants.

(b) (10) Determine the frequency separation between adjacent resonance modes, Δf.

(c) (10) The vacuum is filled with a certain gas whose refractive index has depe-ndance on lightwave frequencies around ω_o : $n(\omega) = n_o + n'(\omega - \omega_o)$. What is the group velocity for light with frequency ω_o in this gas? Give your answer in terms of c, the speed of light in vacuum, and symbols given in this problem and other constants.

(d)(15) What is the mode separation for the adjacent resonance modes, Δf, for the conditions given in (c)?
(hint: Use the result obtained in (c))