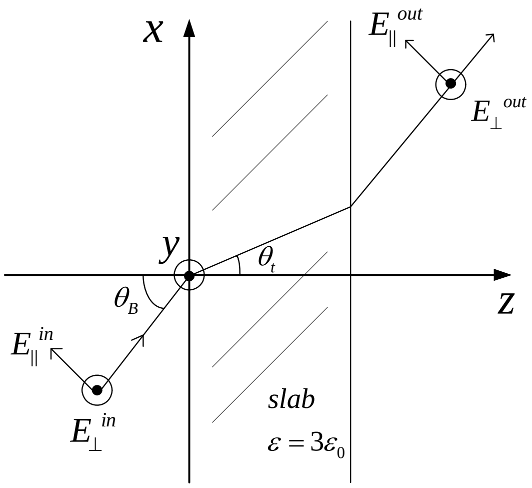
Electromagnetics II 2nd exam. (Prof. Seong-cheol, Kim)

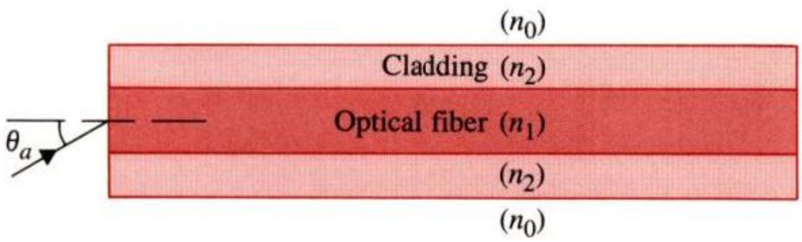
10th Nov. 2007, AM 10:00 ~ 12:00

1. Light carrying equal amounts of power in the two polarizations ($\overline{E}$ perpendicular and $\overline{E}$ parallel to the plane of incidence) is incident on a thick dielectric slab $(\varepsilon = 3\varepsilon_0\ ,\ \mu = \mu_o)$ at Brewster's angle. The slab is in air.

   a) Find θ_B and the angle θ_t of propagation within the dielectric.
   b) Find the ratio, $-\dfrac{E_y}{H_x}$ for the wave transmitted into the dielectric.
   c) Neglecting light that is multiply reflected within the slab, find the ratio of the power carried by the polarization after the light emerges from the slab.



2. For preventing interference of waves in neighboring fibers and for mechanical protection, individual optical fibers are usually cladded by a material of a lower refractive index, as shown in the following figure, where $n_2 < n_1$.



a) Express the maximum angle of incidence θ_a in term of n_0, n_1, and n_2 for meridional rays incident on the core's end face to be trapped inside the core by total internal reflection. (Meridional rays are those that pass through the fiber axis. The angle θ_a is called the acceptance angle, and $\sin\theta_a$ the numerical aperture (N.A.) of the fiber.)

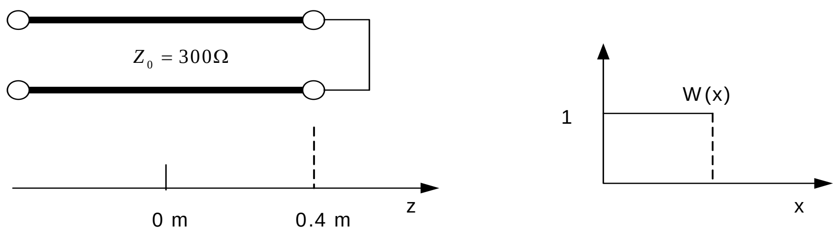
b) Find θ_a and N.A if $n_1 = 2,\ n_2 = 1.74,\ and\ n_0 = 1$.

3. The input impedance of an open- or short-circuited lossy transmission line has both a resistive and a reactive component. Prove that the input impedance of a very short section l of a slightly lossy line $(\alpha l \ll 1 \text{ and } \beta l \ll 1)$ is approximately,

a) $Z_{in} = (R + j\omega L)\, l$ with a short-circuit termination.

b) $Z_{in} = (G - j\omega C)/[G^2 + (\omega C)^2]\, l$ with an open-circuit termination.

4. A semi-infinite, 300Ω transmission line is terminate at z=0.4m by a short. A wave propagates on the line with voltage $V^+(z,t) = 10\omega(10^9 t - 5z)$ where w(x) is the pulse function shown below.



(a) Find the velocity of propagation and capacitance in Farads/m of the line.

(b) Sketch the variation with z of the voltage $V^+(z,t)$ for t=-1, 0, 1, 2 μs.

(c) Sketch the variation of the voltage as a function of time at z=0 .

5. A load impedance 30+j10Ω is connected to a lossless transmission line of length 0.101 λ and characteristic impedance 50 Ω. Use a Smith chart to find (a) the standing-wave ratio, (b) the voltage reflection coefficient, (c) the input impedance, (d) the input admittance, and (e) the location of the voltage minimum on the line.