EE 151 Homework #6

Due November 14, 2006 *in class*

1. (Dielectric waveguide) A symmetric dielectric slab waveguide, as shown in Figure 1, has $n_1 = 1.462$, $n_2 = 1.460$. Suppose the operating wavelength is $\lambda_0 = 1550$nm.

   (a) What is the maximum slab thickness $2d$, for which there would only be a single mode that could propagate in the waveguide?

   (b) Assume $d = 12\mu$m. How many TE modes can propagate simultaneously in the waveguide?

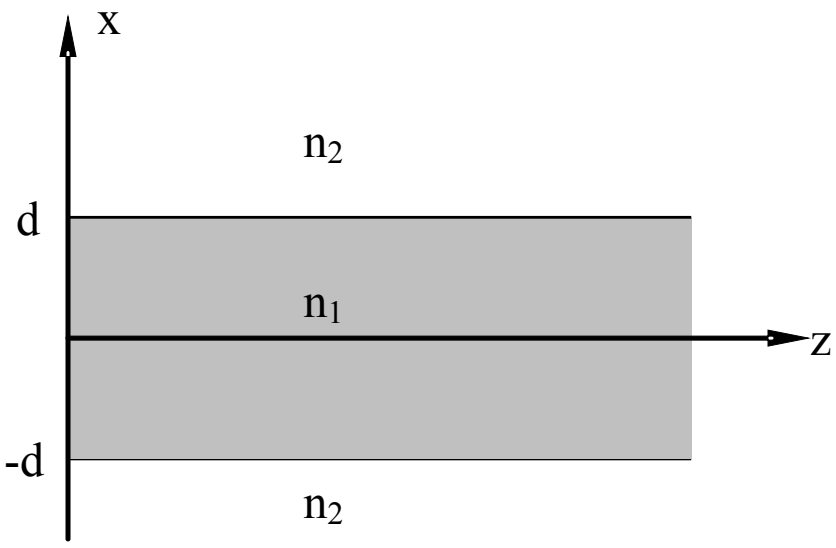

Figure 1

2. (Metal waveguide) A parallel-plate guide is partially filled with two lossless dielectrics (Figure 2) where $\epsilon_{r1} = 4.0$, $\epsilon_{r2} = 2.1$, and $d = 1$cm. At a certain frequency, it is found that the TM_1 mode propagates through the guide without suffering any reflective loss at the dielectric interface. (Hint: Remember Brewster's angle.)

   (a) Find this frequency.

   (b) Is the guide operating at a single TM mode at the frequency found in part (a)?

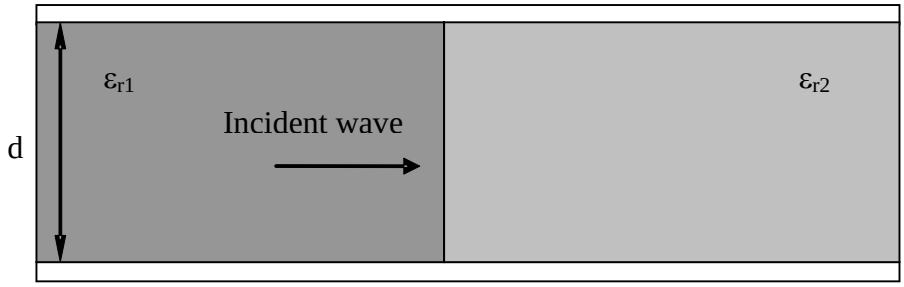

Figure 2

3. (Metal waveguide) In the guide of Figure 2, it is found that that $m = 1$ modes propagating from left to right totally reflect at the interface, so that no power is transmitted into the region of dielectric constant ϵ_{r2}. (Hint: Remember the critical angle.)

   (a) Determine the range of frequencies over which this will occur.

   (b) Does your part (a) answer in any way relate to the cutoff frequency for $m = 1$ modes in either region?

4. (Thin Film-On-Conductor Waveguide) A thin film-on-conductor waveguide is made of a thin film of lossless dielectric (ϵ_d, μ_0) of thickness d on a perfectly conducting ground plane, as shown in Figure 3. The thin film is protected by a lossless dielectric coating (ϵ_1, μ_0). Assume the widths and heights of the coating and the ground plane extend to infinity. The wave propagates in the y direction. Find the cut-off frequencies for the TE modes.

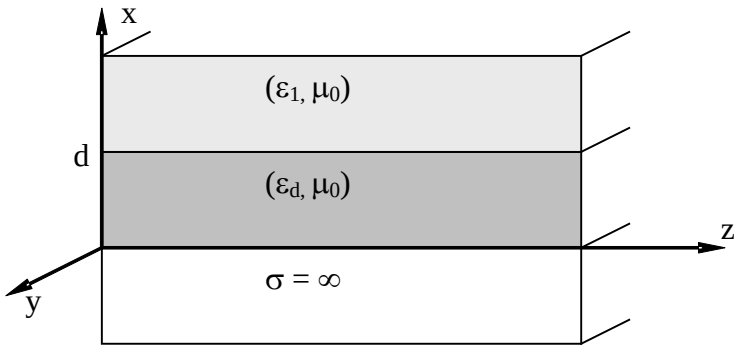

Figure 3

5. (FEMLAB) Use FEMLAB (2D In-plane TE waves model) to simulate the wave propagation in a dielectric slab waveguide. The structure of the waveguide is given in Figure 5. The working wavelength is 1550nm.

   (a) Use the uniform and Gaussian E field distributions at the input to excite the fundamental guided mode. Calculate and compare the coupling coefficients of the two cases. Plot the E field.

   (b) Is the TE_2 mode supported? If so, use a proper source to excite it so that the coupling coefficient is better than 90%. Plot the E field.

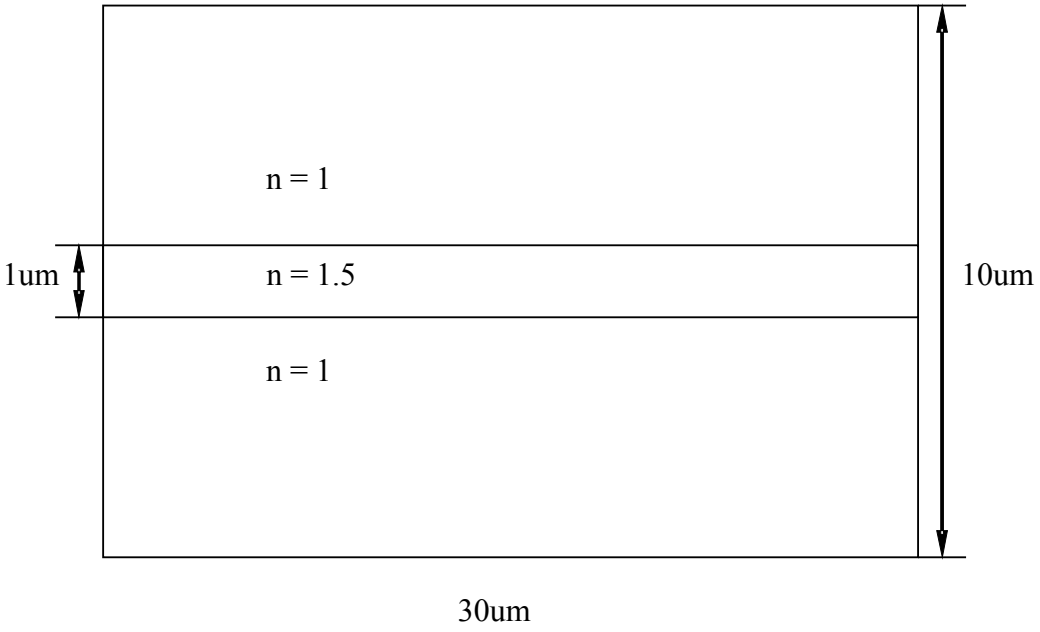

Figure 4