**ENEE 381H Problem Set #7**

12/3/02 - Due 12/12/02

(1) (RW and vD 8.3b) Calculate cutoff frequency for $TE_1$, $TE_2$, $TE_3$, $TM_1$, $TM_2$, and $TM_3$ waves between perfectly conducting planes 15mm apart with an air dielectric. Repeat for a glass dielectric with $\epsilon_r$=4. Suppose excitation at 8GHz is provided at a cross section of the air-filled line and all waves are excited. Which waves(s) will propoagate without attenuation? At what distance will each of the nonpropagating waves be attenuated to $1/e$ of its value at the excitation plane?

(2) (RW and vD 8.7a)For a rectangular waveguide calculate cutoff frequency for $TE_{10}$, $TE_{20}$, $TE_{11}$, $TE_{12}$, $TE_{21}$, $TE_{22}$, $TM_{11}$, and $TM_{22}$ modes. Repeat for a glass dielectric with $\epsilon_r$=4. Suppose excitation at 10GHz is provided at a cross section of the air-filled waveguide and all waves are excited. Which waves(s) will propagate without attenuation? At what distance will each of the nonpropagating waves be attenuated to $1/e$ of its value at the excitation plane?

(3) A plane wave totally internally reflects at the boundary between glass $n$=1.5 and air. The wave is incident at an angle of 80° from the glass. On the air side of the boundary, there is not a propagating wave, but an *evanescent* wave. Calculate the $1/e$ decay distance of this wave into the air.

(4) A $TE_{10}$ mode is propagating in an air-filled rectangular waveguide with dimensions 50mm by 10mm. The frequency of the mode is $10GHz$. The wave strikes a planar lossless plastic layer filling the cross section of the waveguide, which has $\epsilon_r$ =4. The plastic slab is 10mm thick. Calculate:

(a) the guide wavelength in both the air-filled and plastic regions

(b) the impedance of the mode in both regions

(c) the fraction of incident energy transmitted through the slab

Hint: This is a transformed impedance problem.