ENEE 381 Problem Set #6

A guide for studying for the final. Optional for handing in.

One or two of these questions will be on the final examination.

(1) A parallel plate waveguide with plate spacing of 10mm allows TM and TE waves to propagate provided they are above their cutoff frequency. Calculate the cutoff frequency of the TM₁, TM₂, TM₃, TE₁, TE₂ and TE₃ modes.

(2) A waveguide is formed from two perfect conductors. The conductors are spaced by 50mm with a dielectric of $\varepsilon_r=2.25$. For an operating frequency of 10GHz calculate $\beta$, $v_p$, $v_g$, $Z_z$, and $\lambda_g$ for the following modes:
   (a) TEM mode
   (b) TM₁ mode
   (c) TM₂ mode.

(3) For a rectangular waveguide with dimensions 50mm$\times$20mm calculate the cutoff frequencies for the TE₁₀, TE₂₀, TE₂₂, TM₁₁ and TM₂₃ modes. How do these cutoff frequencies change if the waveguide is filled with a lossless dielectric with $\varepsilon_r=4$?

(4) A rectangular waveguide of dimension 50mm$\times$20mm filled with air is being operated at 1.1 times its cutoff frequency for the TE₁₀ mode. Calculate $\beta$, $Z_z$, $v_p$, $v_g$, and $\lambda_g$ for the mode.

(5) A rectangular waveguide of dimension 20mm$\times$10mm is being operated at 1.2 times the cutoff frequency for the TM₁₁ mode. Calculate $\beta$, $Z_z$, $v_p$, $v_g$, and $\lambda_g$ for the mode.

(6) A rectangular waveguide of dimension 50mm$\times$20mm filled with air is being operated at 1.1 times its cutoff frequency for the TE₁₀ mode. The TE wave reaches a section of the waveguide that is now completely filled with a lossless dielectric with $\varepsilon_r=3$. Calculate the reflection coefficient in magnitude and phase, VSWR, and the fraction of the incident power that passes into the loaded waveguide section.

(7) A waveguide of dimension 20mm$\times$10mm that is filled with air carries a TE₁₀ mode at a frequency of 10GHz. The total power being transferred down the guide is 1W. What is the peak electric field amplitude in the waveguide?