ECE 3065

# MIDTERM 2 (max 115%)

## Problems

**1.** A rectangular waveguide filled with organic material $\epsilon_r$=3.1 is used for UltraWideband (UWB) applications (3-12 GHz) and has a cross-section $1.in \times 0.4in$.

(a) Calculate the cutoff frequency $f_{co}$ for the dominant (identify it) and the first two higher-order TE modes. (10%)

(b) Calculate the cutoff frequency $f_{co}$ for the dominant (identify it) and the first two higher-order TM modes. (10%)

(c) Utilizing the results from (a),(b) determine how many modes will propagate for the frequency range of operation. Identify the sub-bands that the TE or the TM dominant mode could be used for single-mode operation. (10%)

(b) Determine the transverse-wave impedance and propagation constant at 3 and 12 GHz for the dominant TE mode and for the dominant TM mode. How close are the impedance values to the TEM value? Determine the value of the transverse-wave impedance at $f = 30GHz$ WITHOUT CALCULATING IT and justify your answer. (10%)

**2.** In a material process quality sensor, a perpendicularly polarized monochromatic laser wave in air is obliquely incident upon a planar Air-MLO interface at an incidence angle of $45^o$. The dielectric constant of Multilayer Organic (MLO) is 4 (MLO is a nonmagnetic material; assume it is lossless).

(a) If the electric field amplitude of the incident wave is 1 mV m (phasmatoscopy), determine the electric field amplitude of the transmitted wave (15%).

(b) How many db's it's lower than the incident field? (10%)

(c) If the polarization were parallel, calculate the angle of incidence that would maximize the transmission coefficient. Give the optimal value of the transmission coefficient. (10%)

**3.** (a) Find the ABCD and Z matrices of the series combination of a lossless transmission line with $Z_o$=50Ω and phase delay of 60 degrees,a shunt capacitance C=10pF and a series inductor L=5nH used for WLAN 802.11a applications at 5.8GHz. (10%)

(b) Is this a reciprocal and/or lossless structure? Justify your answers (10%)

(c) Give the $\pi-$equivalent circuit. (10%)

(d) This device was measured at 2.4 GHz for 802.11g applications. The reflection coefficient at port 1 (left) with matched port 2 was 0.8<30 deg and the transmission coefficient from port 1 to port 2 was 0.6<45deg. Write the 2x2 scattering matrix of the module. (10%)

**GOOD LUCK!!!**