LE 333 Assignment #3

1. A load impedance $Z_L = 100 + j50\ \Omega$ is connected to a transmission line of length $\lambda/8$ with characteristic impedance $Z_0 = 50\ \Omega$.

a) Calculate the input impedance.

b) Use the Smith chart to find the input impedance.

c) Find the length of the line such that the input impedance becomes real from the input impedance formula and by using the Smith chart.

2. Derive Equations (3.5a-d) from equations (3.3) and (3.4).

3. Show that TE and TM modes in rectangular waveguides satisfy the orthogonality condition, namely

$$\int_S \mathbf{E}_i \times \mathbf{H}_j^* \cdot d\mathbf{s} = A_{ij}\delta_{ij}$$

where i, j denote the mode indices, S denotes the waveguide cross section, A_{ij} denotes the mode power, and δ_{ij} denotes the Kronecker delta, which equals 1 if $i = j$, and equals 0 otherwise.

This orthogonality indicates that there are no power couplings among different modes.

4. Plot the frequency response of the TE_{10} mode attenuation (α_c, α_d), in dB/m, for K-band waveguide made from brass, and is filled with a dielectric material having $\varepsilon_r = 2.2$ and $\tan\delta = 0.002$.

5. Find the cutoff frequencies of the TE_{1n} and TM_{1n} (n = 1,2,3) modes of a rectangular waveguide with $a = 2.286$ cm, $b = 1.016$ cm and is filled with

(a) air

(b) dielectric with $\varepsilon_r = 2.56$.