Problem Set #4
ECE357/ECE320
University of Toronto

1) Let $Z_L = 60 + j\,43\,[\Omega]$ and $Z_o = 50\,[\Omega]$. Find the input impedance with $l = 0.32$ [m] and line wavelength of $\lambda = 0.854$ [m].

2) The inductance and capacitance of a lossless 50 [Ω] line are 0.251 [μH/m] and 99.5 [pF/m]. The line is attached to a source of $10\cos(2\pi 10^6 t)$ with internal impedance of 1[Ω]. The length of the line is 5 [m] and is terminated on a load resistance of 50 [Ω].
a) What are the instantaneous voltage and current at any point?
b) What is the power delivered to the load?

3) This problem answers the question why we want to minimize the standing wave ratio on the line. Let P_i be the incident time averaged power approaching a point on a lossless line, P_r the time averaged reflected power on the line, and P_t the time averaged transmitted power available to do work on the load. You can think of the P_t as a useful power since, for example, it can be radiated by an antenna connected to the line. Show that the following is true:

$$P_t = P_i - P_r = \frac{\left|v_o^+\right|^2}{2Z_o}\left(1-\left|\Gamma_L\right|^2\right) = P_i\left(1-\left|\Gamma_L\right|^2\right)$$

4) The capacitance of a 0.6 [m] long lossless line measured at 100 [KHz] was 54 [pF] and its inductance was equal to 0.3 [μH].
a) Determine Z_o
b) Calculate X_{io} and X_{is} (open and short circuit impedance) at 10 MHz
c) What is the dielectric constant of the insulating medium used in the transmission line?

5) The characteristic impedance of an air-line lossless transmission line is $75\,[\Omega]$. Use a Smith chart to find the input impedance and input admittance at 200 [MHz] of such a line that is a) 1 [m] long and open-circuited, and (b) 0.8 [m] long and short-circuited.

6) For a general transmission line (lossy or lossless)
a) Express $V(z)$ and $I(z)$ in terms of the load voltage V_L and load current I_L in exponential form and in hyperbolic form
b) Express $V(z)$ and $I(z)$ in terms of the voltage V_i and current I_i at the input end in exponential form and hyperbolic form.

7) A d-c voltage V_o is applied at $t = 0$ to the input terminals of an open-circuited air-dielectric line of length l through a series-resistance equal to $R_o/2$, where R_o is the characteristic resistance of the line.

a) Draw the voltage reflection diagram

b) Sketch $V(z = 0, t)$.

c) Sketch $V(l/2, t)$.