Problem Set #3

ECE357 /ECE320
University of Toronto

1. Plot the voltage standing wave patterns for the case of a lossless line

   (a) Terminated with an open ($R_L \to \infty$).

   (b) Terminated with a short ($R_L \to 0$).

   (c) How are these patterns different from those obtained in class?

2. The standing wave ratio S on a lossless 50Ω line ($Z_0 = R_0 = 50\Omega$) terminated in an unknown load impedance is found to be 3. The distance between successive voltage minima is 20cm and the first minimum is located 5cm from the load. Determine
   a. the reflection coefficient Γ,
   b. the load impedance Z_L,
   c. the length of a lossless line and a terminating resistive load that can replace the original load (Z_L) without effecting the waveforms to the left of the original Z_L.

3. A lossless transmission line has a capacitance of 200pF/m and an inductance of $0.5\,\mu$H/m. It is excited with a 1kHz sinusoidal source. The magnitude of the voltage measured across a $35\,\Omega$ load is 100V. Find
   a. the line characteristic impedance R_0,
   b. the voltage reflection coefficient Γ at the load,
   c. the phase velocity v_p,
   d. the wavelength λ_0,
   e. the forward and backward traveling wave amplitudes $\left|V_0^+\right|$ and $\left|V_0^-\right|$,
   f. the line propagation constant β.

4. A transmission line of characteristic impedance $R_0 = 50\Omega$ is to be matched to a load impedance of $Z_L = 40 + j10\Omega$ through a length l' of another transmission line of characteristic impedance R_0'. What are the required l' and R_0' for matching?

5. A generator with an open circuit voltage $V_g = 10\cos(8000\pi t)$ [V] and internal impedance $Z_g = 40 + j30\,[\Omega]$ is connected to a $50\,[\Omega]$ distortionless line. The line has a resistance of $0.5\ [\Omega/m]$ and its lossy dielectric medium has a loss tangent of 0.18%. The line is 50 [m] long and is terminated in a matched load. Find
   a. the instantaneous expressions for the voltage and current at an arbitrary location on the line,
   b. the instantaneous expressions for the voltage and current of the load,
   c. the average power transmitted to the load.

6. A 2m lossless air-spaced transmission line with a characteristic impedance of $50\,\Omega$ is terminated with an impedance of $40 + j30\Omega$. At an operating frequency of 200MHz the phase velocity in the line is the same as the speed of light in vacuum. What is the line input impedance?

7. A sinusoidal voltage generator with $V_g = 0.1\angle 0$ V and internal impedance $Z_g = R_0$ is connected to a lossless transmission line having a characteristic impedance $R_0 = 50\Omega$. The line is l meters long and is terminated with a load resistance $R_L = 25\Omega$. Find
   a. V_i, I_i, V_L, I_L in terms of the line length l,
   b. the standing wave ratio on the line,
   c. the average power delivered to the load.