Homework 1
EE381 Electric & Magnetic Fields (Fall 2018)
Monday, August 27, 2018

1) PE11.1 Hint: Lossy transmission line. Time to do a bit of reading.

2) 11.4 Assume $\sigma_c \to \infty$, i.e., perfect electrical conductors.

3) A twin-lead transmission line is made of brass wires with diameters of 1.2 mm, separated by 8 mm, embedded in a dielectric insulator characterized by $\varepsilon = 1.6\varepsilon_0$, $\mu = \mu_0$, and $\sigma = 5 \times 10^{-6}$ S/m. Determine the per-unit-length parameters R, L, C, and G at a frequency of 530 MHz.

4) A lossless twin-lead transmission line ($Z_0 = 250\,\Omega$, $u = 2.75 \times 10^8$ m/s) of length $l = 1.65\lambda$ is terminated with a load $Z_L = 160 + j140\ \Omega$. The transmission line is connected to a signal generator operating at 950 MHz. Determine (a) the inductance per-unit-length L and capacitance-per-unit-length C, (b) phase constant β, wavelength λ, and length l of the transmission line, and (c) input impedance Z_{in}.

5) A lossless coaxial transmission line ($Z_0 = 75\ \Omega$, $u = 2.3 \times 10^8$ m/s) of length $l = 2.3\lambda$ is terminated with a load $Z_L = 40 - j20\ \Omega$. The transmission line is connected to a 75 Ω signal generator operating at 2.4 GHz with a phasor voltage $V_g = 6\angle 0°$ V. First, sketch the transmission line circuit. Then, determine (a) the phase constant β, wavelength λ, and length l (m) of the transmission line, (b) input impedance Z_{in}, (c) input phasor current I_0 & voltage V_0.

6) A lossless transmission line ($Z_0 = 40\ \Omega$, $u = 2.4 \times 10^8$ m/s), terminated with an unknown load, has an input impedance of $20 + j80\ \Omega$. The transmission line is connected to a 50 Ω generator operating at 4.1 GHz with phasor voltage $V_g = 16\angle 0°$ V. First, sketch the transmission line circuit. Then, determine (a) the phase constant β, (b) phasor input current I_0 & voltage V_0, and (c) phasor forward V_0^+ & backward V_0^- voltage waves.

Note: Express all phasor quantities, e.g. currents and voltages, in the polar/phasor format with angles in degrees (e.g. $10\angle 30°\,\text{V}$, $12\angle 140°\,\text{mA}$). Express impedances in rectangular format (e.g., $Z_L = 10 + j30\,\Omega$).

Due Friday, August 31, 2018