Homework 1
EE381 Electric & Magnetic Fields (Fall 2017)
Friday, August 25, 2017

1) 11.2

2) A planar line of width 2 mm is made on Rogers Corporation RO4003C substrate which has a dielectric substrate with a relative permittivity of 3.55, loss tangent of 0.0021 ($\sigma = 10^{-3}$ S/m), thickness of 0.813 mm, and 0.5 oz copper cladding (17 μm thick). When operated at 2.4 GHz, find the per-unit-length parameters *R*, *L*, *C*, and *G*. [Hint: Consult Appendix B for copper material properties.]

3) A twin-lead transmission line, made with perfectly conducting wires of diameter 2 mm and a center-to-center spacing of 12 mm, is in a vacuum chamber. It is connected to a signal generator operating at 105.1 MHz. Find (a) the resistance per-unit-length *R*, inductance per-unit-length *L*, conductance per-unit-length *G* & capacitance-per-unit-length *C*, (b) phase constant β, (c) wavelength λ, (d) phase velocity, and (e) characteristic impedance Z_0 of the transmission line.

4) A lossless twin-lead transmission line ($Z_0 = 200\ \Omega$, $u = 2.4 \times 10^8$ m/s) of length $l = 0.7\lambda$ is terminated with a load $Z_L = 80 + j60\ \Omega$. The transmission line is connected to a signal generator operating at 360 MHz. Find (a) the inductance per-unit-length *L* and capacitance-per-unit-length *C*, (b) phase constant β, wavelength λ, & length *l* of the transmission line, and (c) input impedance Z_{in}.

5) A lossless coaxial transmission line ($Z_0 = 52\ \Omega$, $u = 2 \times 10^8$ m/s) of length $l = 21.9$ cm is terminated with a load $Z_L = 40 - j60\ \Omega$. The transmission line is connected to a 75 Ω signal generator operating at 2.1 GHz with a phasor voltage $V_g = 12\angle 0°$ V.

   First, sketch the transmission line circuit. Then, determine (a) the phase constant β, wavelength λ, & length *l* (in terms of λ) of the transmission line, (b) input impedance Z_{in}, and (c) total input phasor current I_0 & voltage V_0.

6) A lossless transmission line ($Z_0 = 50\ \Omega$, $u = 2.5 \times 10^8$ m/s), terminated with an unknown load, has an input impedance of $130 + j80\ \Omega$. The transmission line is connected to a 50 Ω generator operating at 1.2 GHz with phasor voltage $V_g = 6\angle 0°$ 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. $10\angle 30°$ V, $12\angle 140°$ mA). Express impedances in rectangular format (e.g., $Z_L = 10 + j30\ \Omega$).

Due Friday, September 1, 2017.