PROBLEM SET 1
ECE 311 Autumn Quarter 2008

Assigned: September 24th
Due: October 3rd in class Instructor: Joel Johnson

Problem 1

If "appreciable" means "larger than 10%," find the highest frequency for which the following devices can be treated using standard circuit theory.

(a) a CMOS device with horizontal dimensions of 0.22 microns by 0.22 microns

(b) a 15 cm long wire used in the ECE circuits lab

(c) a power line with length 400 km

(d) a 1.2 m long USB cable

Problem 2

Given $a = 8 + 7j$ and $b = 3 - 9j$, find

(a) the polar form for a.

(b) the rectangular form for $a + b$.

(c) the rectanglar form of a / b.

(d) the polar form of ab.

(e) write $v(t) = 4\sin(\omega t + 5°)$ V in phasor form.

(f) write $v(t) = 2\cos(\omega t) - 4\sin(\omega t)$ V in phasor form.

Problem 3

A transmission line operated at a frequency of 3 GHz has $\gamma = 0.2 + j5\pi$ (per meter). It is also known that the line's characteristic impedance is $Z_0 = 100 + j1$ Ohms.

(a) Is this a lossless line?

(b) Find the attenuation constant α and the phase constant β. Include units.

(c) Find the parameters R', G', L', and C' of this line. Include units.

Problem 4

The voltage on a transmission line is known to be

$$\tilde{V}(z) = 0.4e^{-j5\pi z} + 0.4e^{j5\pi z} \text{ Volts}$$

with z in units of meters.

(a) Find V_0^+ and V_0^-.

(b) Find α, β, and γ.

(c) If the line has characteristic impedance $Z_0 = 100$ Ohms, find $\tilde{I}(z)$.

(d) Find $v(z, t)$. Try to simplify as much as possible.

(e) Sketch $v(z, 0)$, $v\left(z, t = \frac{\pi}{2\omega}\right)$, and $v\left(z, t = \frac{3\pi}{2\omega}\right)$ (i.e. voltages versus space at the specified times) for z=0 to 0.8 m. Interpret your results. Do these plots look like the voltage along a wire in circuit theory?