EE 363M Spring 2000, Homework Set 2
Wed. Feb. 16; Due: Wed. Feb 23

1. (15 pts) (from: Ramo, problems 5.7b, 5.7g, and 5.7h): Using the general input impedance formula for and L-C T-line:

$$Z_i = Z(z = -l) = Z_o \frac{Z_L + jZ_o \tan(\beta l)}{Z_o + jZ_L \tan(\beta l)} \quad .$$

find Z_i when:
(a) the load is a short.
(b) the load is an open.
(c) the line is a half wavelength long line terminated by Z_L.
(d) the line is a quarter wavelength long line terminated by Z_L.
(e) the line length is **not** near a quarter wavelength and $Z_L << Z_o$.

hint: use the first order terms of a binomial expansion for Z_i to show that

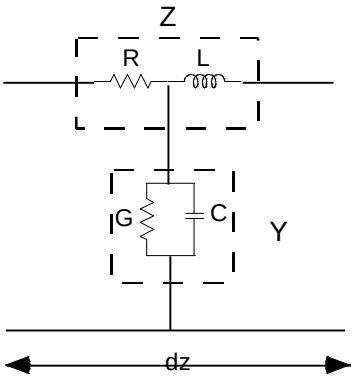
$$Z_i \approx jZ_o \tan(\beta l) + Z_L \sec^2(\beta l)$$

(e) the line length is **not** near a quarter wavelength and $Z_L >> Z_o$.

hint: use the first order terms of a binomial expansion for Z_i to show that

$$Z_i \approx -jZ_o \cot(\beta l) + \frac{Z_o^{\,2}}{Z_L} \csc^2(\beta l)$$

2. (10 pts) Consider a "general" RLGC transmission line as shown below:



Specific parameter values:
R = 1 ?/cm,
L = 2 nH/cm,
G = 0,
C = 1 pF/cm.

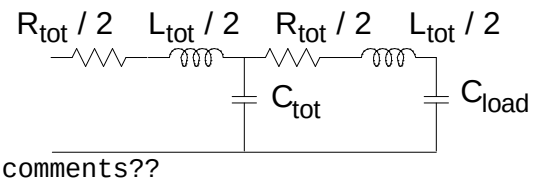
Recall that the input impedance for a generalized T-line is:

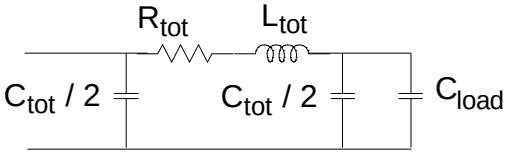
$$Z_i = Z(z = -l) = Z_o \frac{Z_L + Z_o \tanh(\gamma l)}{Z_o + Z_L \tanh(\gamma l)} \quad .$$

Plot the "effective" capacitance versus frequency (use a log frequency scale, and go from "low" frequency up to 10 GHz) for a 10 cm long line with a 10 pF load, where $C_{effective}$ is given by:

$$C_{effective} = \frac{-1}{\omega \cdot \mathrm{Im}(Z_i)} \quad .$$

On the same plot, plot the effective capacitance obtained using the two circuit models shown below:





Any comments??