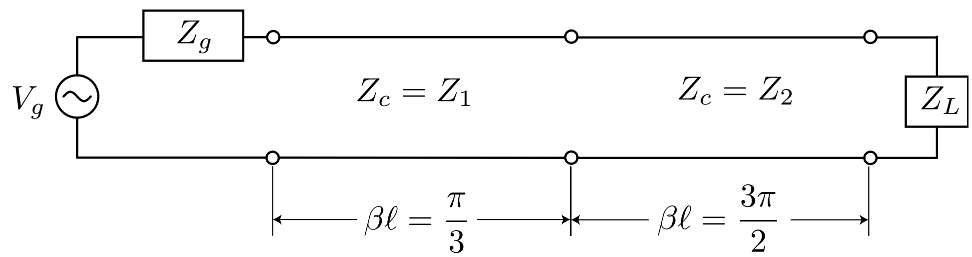
University of California, Berkeley | *Spring 2004*
EECS 117 | *Prof. A. Niknejad*

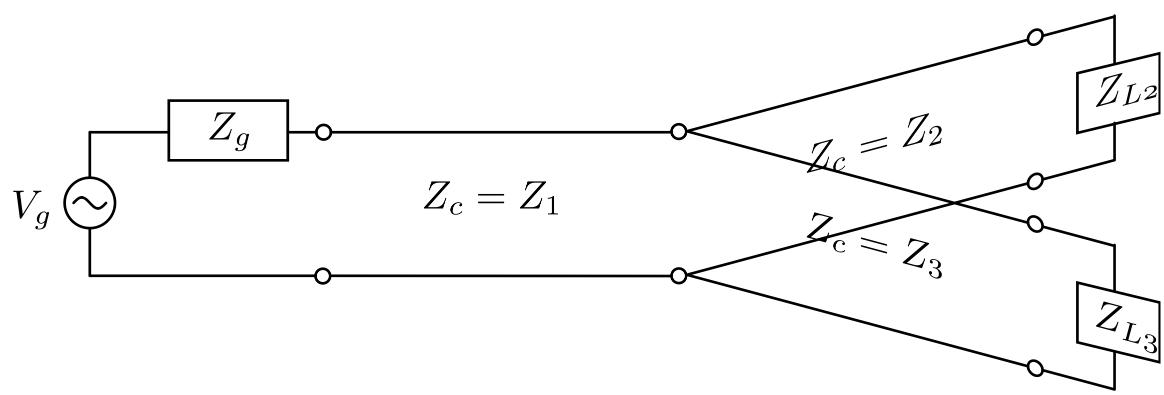
Problem Set 2
Due Thursday February 5, 2004

1. The transmission lines below are excited by a 1GHz sinusoidal voltage source with $V_g = 10$V (peak) and $Z_g = 300\Omega$. The first transmission line has characteristic impedance $Z_1 = 300\Omega$ but the second line has a characteristic impedance $Z_2 = 100\Omega$. The load resistance $R_L = 100\Omega$ in parallel with a capacitor $C = 10$pF.



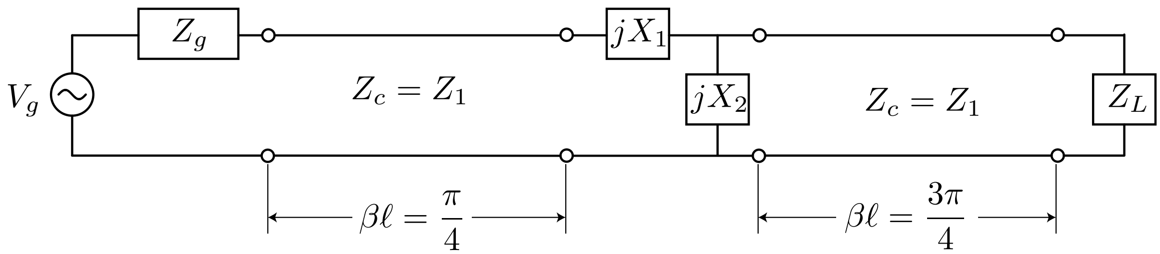
   (a) Find the steady-state current and voltage on each transmission line.
   (b) Calculate the VSWR on each line.
   (c) Calculate the average power delivered to the load.
   (d) Find the power flow into the transmission line from the source. Explain why this power should equal the power delivered to the load.

2. Design the following system to deliver 50W of power asymmetrically into each load. It is desired to deliver 10W into Z_{L1} and the remaining power into Z_{L2}. Size Z_{L1} and Z_{L2} and the transmission line characteristic impedances Z_1, Z_2 and Z_3 to achieve 0 dB SWR on each line.

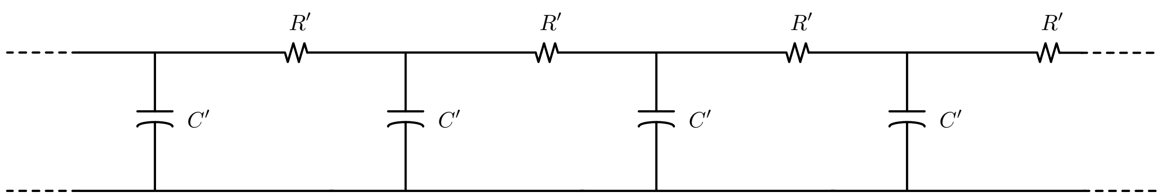


3. (Ramo et al., "Fields and Waves in Communication Electronics" problem 5.10b) The standing wave radio on an ideal 70-Ω line is measured as 3.2, and the voltage minimum is observed 0.23 wavelength in front of the load. Find the load impedance using the Smith chart.

4. (Collin, "Foundations of Microwave Engineering" problem 4.11) For the following microwave circuit, evaluate the power transmitted to the load Z_L. Find the standing-wave ratio in the two transmission-line sections. Assume $Z_g = Z_1$, $Z_L = 2Z_1$, $X_1 = X_2 = Z_1$, $V_g = 5V$ (peak). Repeat your calculation with the Smith Chart.



5. Consider a lossy RC line shown below. This is a physical model for a circuit where the series loss $R' \gg \omega L'$ dominates over the inductance of the line. The particular example is for an 1MΩ IC resistor with parasitic capacitance of 100fF with length $\ell = 500\mu$m.



(a) Using the general distributed circuit analyzed in class, find the propagation constant and velocity for the line.

(b) Find the input impedance for an arbitrary termination.

(c) Show that the shorted line looks like a resistor at low frequency. What's the pole frequency? How does it compare to a 1-section lumped approximation to the line.

(d) Show that the open line looks like a lossy capacitor at low frequency. What's the equivalent series resistance of the capacitor? How does it compare to a 1-section lumped approximation to the line.

(e) Plot the normalized voltage along the shorted line at a frequency of 1GHz. Compare the plot to an ideal resistor.