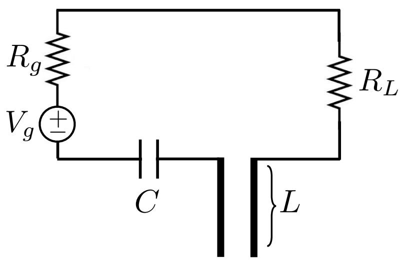
1. Consider a lossless TL which is short circuited at both ends. If $l = 5$ m is the length of the line, and $v = \frac{1}{3}c = 10^8$ m/s for the line,

   a) What are all the resonance frequencies of the line — frequencies at which source-free *oscillations* (standing waves) of voltage and current are sustained on the line — expressed in MHz units? **Hint:** to satisfy the "open" boundary conditions at both ends of the line, we want the current phasor to vanish at $z = 0$ and $z = l$ when the oscillation frequency is resonant.

   b) Sketch the shapes of current magnitude $|I(z)|$ vs z for the line corresponding to the *three lowest resonance frequencies.* Label each plot clearly and explain each briefly.

   c) Repeat (b) for voltage magnitude $|V(z)|$ vs z.

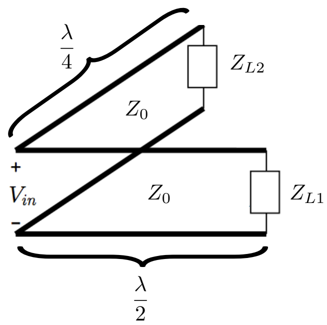
2. Consider the circuit shown below, where a resistor, $R_L = 50\ \Omega$, and a capacitor C, are connected in series with an open-circuited transmission line stub with characteristic impedance $Z_0 = R_L$, $v = c$, and length $L = 160$ cm (see diagram).



   a) What is the input impedance, $Z(L)$, of the open T.L. stub?

   b) The circuit is driven by a voltage source of magnitude V_g at a frequency of 50 MHz, which has internal resistance $R_g = R_L$. If the voltage at the load, V_L, equals $V_g/2$, what is the capacitance C?

3. Two transmission line segments each having characteristic impedance $Z_0 = 100\ \Omega$ are connected in parallel and share input voltage $V_{in} = j10$ V. One transmission line has electrical length $l = \frac{\lambda}{2}$ and is terminated by a resistive load $Z_{L1} = 200\ \Omega$, while the other has electrical length $l = \frac{\lambda}{4}$ is terminated by $Z_{L2} = 50\ \Omega$.



   a) What is the voltage V_{L1} across Z_{L1}?

   b) What is the voltage V_{L2} across Z_{L2}?

   c) What is the current I_{L1} through Z_{L1}?

d) What is the current I_{L2} through Z_{L2}?

e) What is the input impedance Z_{in} associated with the combined TL network?

f) What is the total time-averaged power absorbed by the two resistive loads?

4. A quarter-wavelength long transmission line section having characteristic impedance $Z_o = 100\,\Omega$ is terminated by an unknown impedance Z_L at one end. The input current phasor at the other end is $I_{in} = 0.5\angle 0°$ A. Let V_{in} and V_L denote input and load voltage phasors, respectively, with directions defined in a compatible way with one another and with I_{in}.

   a) Assuming that the load is not shorted (i.e., $Y_L = \frac{1}{Z_L} \neq 0$) what is V_L?

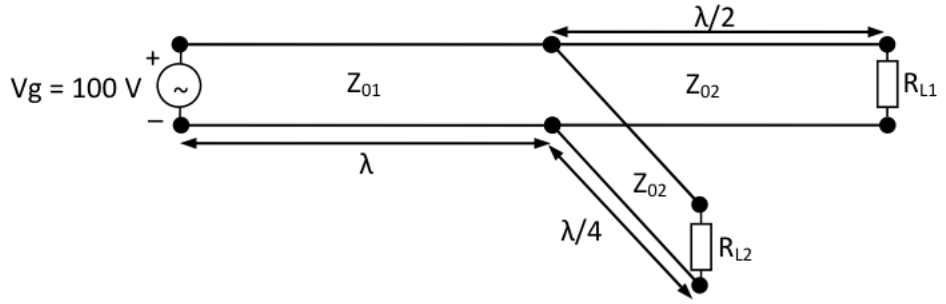
   b) Is it possible for $I_{in} = 0.5\angle 0°$ A if the load is a short? Discuss your answer.

   c) What is V_{in} if $Z_L = 50\,\Omega$?

5. In the transmission-line circuit shown below all lines are lossless, $Z_{01} = 2Z_{02} = 100\,\Omega$ and $R_{L1} = R_{L2} = 50\,\Omega$. Calculate the following:

   a) Voltage and current phasors at the two loads,

   b) Time-average power dissipated at the two loads.



6. Consider a lossless TL having electrical length $l = \lambda$, characteristic impedance $Z_0 = 50\ \Omega$, propagation velocity $v = c$, and resistive load $Z_L = 150\ \Omega$. The TL is connected in series with an open circuit voltage source $V_g = 30e^{-j\frac{\pi}{2}}$ V having Thevenin impedance R_g, and the voltage across the load Z_L is known to be $V_L = -j10$ V.

   a) What is I_L?

   b) At what distance(s) d along the TL (where $d = 0$ at the load end) is the line impedance $Z(d) = Z_L$?

   c) What is $V(d = \frac{\lambda}{4})$ and $I(d = \frac{\lambda}{4})$?

   d) What is $Z(d = \frac{\lambda}{4})$?

   e) What is $V(d = \frac{\lambda}{2})$ and $I(d = \frac{\lambda}{2})$?

   f) What is R_g, the Thevenin impedance of the generator?