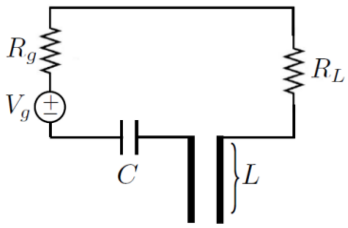
- Homeworks are due Fridays at 4:59:00 p.m. Late homework will not be accepted.
- Homeworks are to be turned in to Gradescope.
- Any deviation from the following steps will result in a 5 point penalty:
  - Write your name, netID, and section on each page of your submission.
  - Start each new problem on a new page.
  - Scan the homework as a PDF (rather than taking pictures). Use a free scanning app if you do not have access to a photocopier.
  - Upload the PDF to Gradescope and tag each problem's location in the PDF.
- Each student must submit individual solutions for each homework. You may discuss homework problems with other students registered in the course, but you may not copy their solutions. If you use any source outside of class materials that we've provided, you must cite every source that you used.
- Use of homework solutions from past semesters is not allowed and is considered cheating. Copying homework solutions from another student is considered cheating.
- Penalties for cheating on homework: a zero for the assignment on the first offense, and an F in the course on the second offense.

Reading Assignment: Kudeki: Lectures 33-35

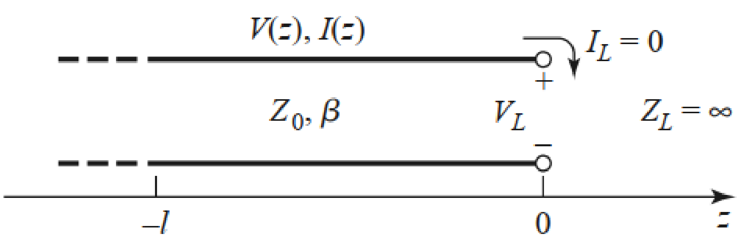
1. Consider the circuit shown below, where a resistor, $R_L = 50\ \Omega$, and a capacitor C, are connected in series with an open-circuited transmission line stub with characteristic impedance $Z_0 = R_L$, $v = c$, and length $L = 75$ cm (see diagram).



   a) What is the expression for 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?

2. Consider the open-circuited transmission line shown in the figure below.

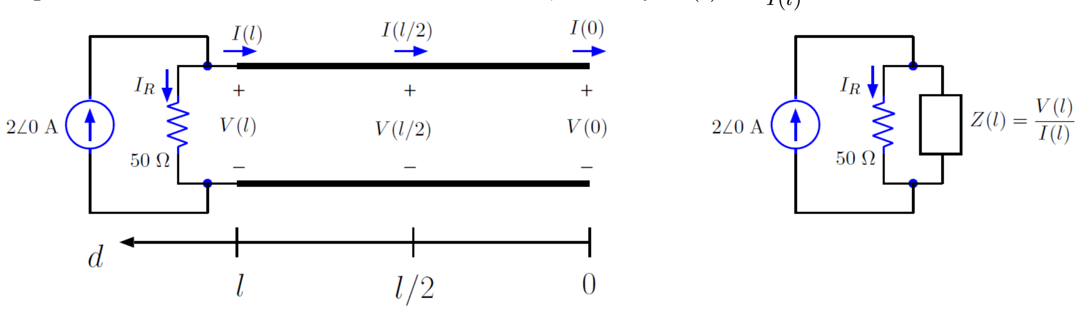


   a) What is the expression for the input impedance, $Z(-l)$, of the open T.L. stub?

   b) If the open-circuited line has $Z_o = 100\,\Omega$ and an effective dielectric constant of 1.65, find the shortest length of this line that appears at its input as a capacitor of 5 pF at 2.5 GHz.

   c) Repeat (b) for an inductance of 5 nH.

3. Consider a transmission line segment of propagation velocity $v = \frac{1}{3}c = 1 \times 10^8$ m/s, characteristic impedance $Z_o = 50\,\Omega$, and length l. As shown in figure (a) below, the segment is connected *in parallel* with a 50 Ω **resistor** and an ideal **current source** $i(t) = \text{Re}\{Ie^{j\omega t}\}$, where $I = 2\angle 0$ A is the source current phasor and $\omega = \pi \times 10^8$ rad/s; figure (b) depicts an *equivalent circuit* in terms of input impedance of the transmission line at $d = l$, namely $Z(l) \equiv \frac{V(l)}{I(l)}$.



`(a) Transmission line circuit` `(b) Equivalent circui`

In answering the following questions assume that the circuit above is in sinusoidal steady-state:

a) Since an "open termination" is located on the line at $d = 0$, what is the pertinent "boundary condition" involving the phasor $I(0)$ for all possible line lengths l?

b) What is the smallest non-zero value of l (in m) if phasor $I_R = 2\angle 0$ A? Explain.

c) For l determined in part (b), what is phasor $V(l/2)$? Explain.

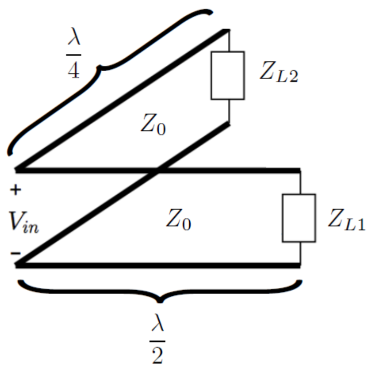
d) For l determined in part (b), is $I(l/2) = 0$ possible? Explain.

e) What is the smallest non-zero value of l if $I_R = 0$?

f) Given that $I(l/2) = 0$, what is the smallest possible value of l? Explain

g) For l determined in part (f), what is $V(l)$? Explain.

4. 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?

5. 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?

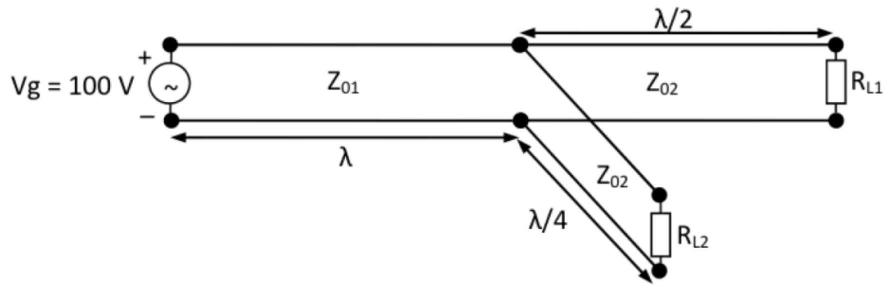
b) Is it possible for $I_{in} = 0.5\angle 0°$ A if the load is a short? Discuss your answer.

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

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

a) Voltage and current phasors at the two loads,

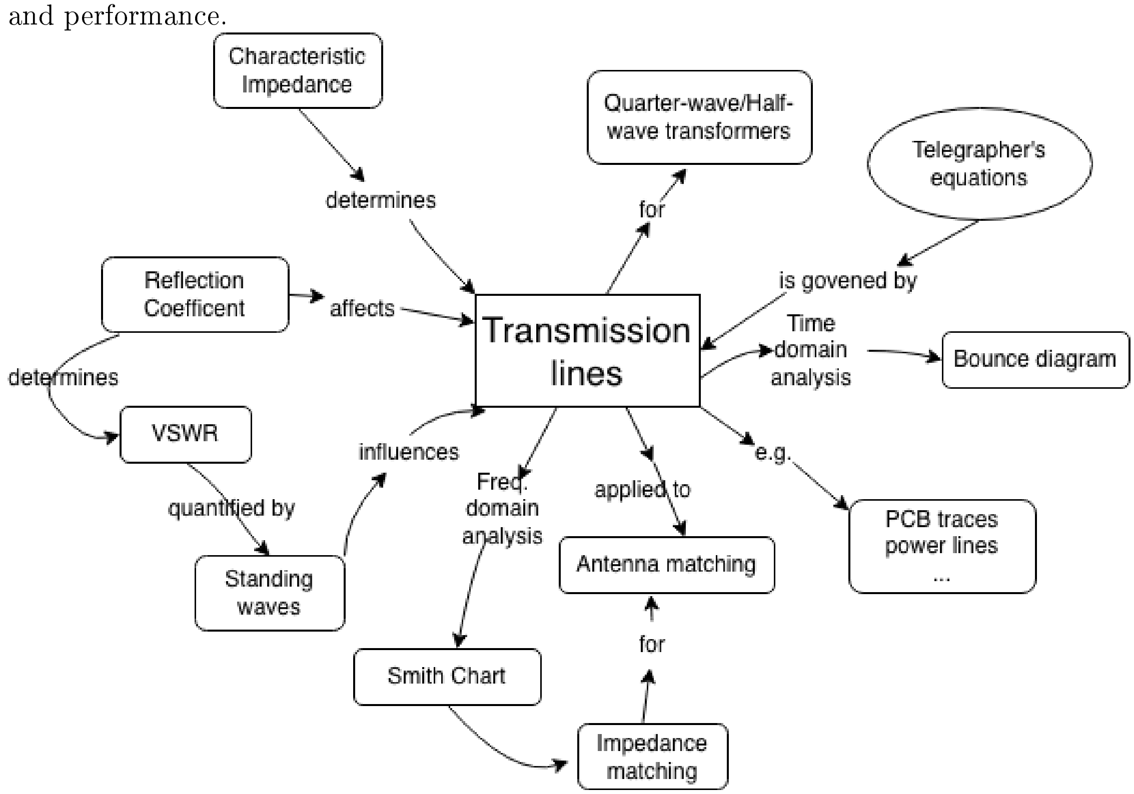
b) Time-average power dissipated at the two loads.



7. This homework activity helps you visualize how key ECE 329 topics are connected and how they apply to real engineering problems.

   a) Have you encountered concept map before? Where or in which class?

   Review the sample concept map below showing "Transmission Lines" at the center, connected to ideas such as characteristic impedance, reflection coefficient, standing waves, impedance matching. Note how the map:
   • Uses labeled arrows (e.g., determines, affects, used for) to show relationships
   • Links core theory to real-world applications (e.g., PCB traces, RF mixers, antenna matching)
   • Highlights how understanding these links helps engineers improve system efficiency, reliability, and performance.



   b) Build your own concept map centered on one major ECE 329 topic, such as:
   • Plane waves and reflection at boundaries
   • Transmission-line behavior and impedance matching

• Power flow and standing-wave ratio (SWR)
• Polarization of electromagnetic waves
• Smith Chart as a visualization and design tool
• Maxwell's equations and field relationships.

Your map should:
• Include 8–12 nodes (key ideas, equations, or examples)
• Use connecting phrases to describe relationships (causes, depends on, used in, etc.)
• Include at least two links to real-world systems (e.g., wireless links, PCB interconnects, shielding)
• Show how mastering these concepts creates value for your team/project/company/society (pick one or come up with your own)—through innovation, performance, or reliability
You may hand-draw or use a digital tool (Lucidchart, draw.io, PowerPoint, etc.).