- Homeworks are due Thursdays 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 28-30

1. Consider a T.L. with characteristic impedance $Z_o = 100\,\Omega$, length $l = 600$ m, and propagation velocity $v = \frac{1}{\sqrt{\mathcal{LC}}} = c = 3\times 10^8$ m/s. A voltage source $f(t)$ with an internal resistance $R_g = Z_o$ is connected to one end of the T.L. (at $z = 0$) and the other end ($z = l$) is terminated by a load resistance $R_L = Z_o/4$.

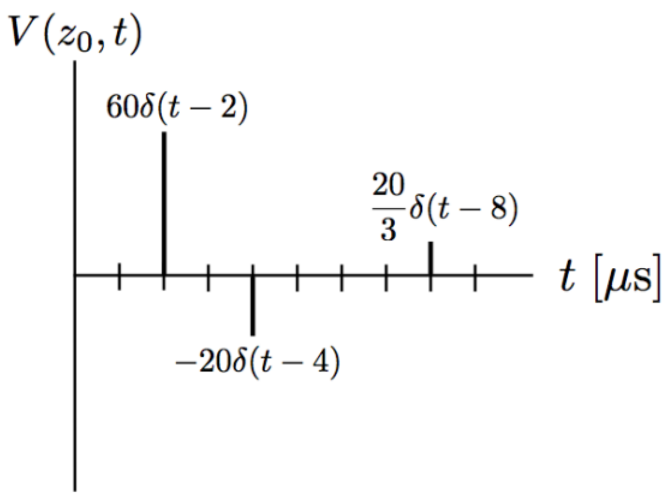
   a) Construct two "bounce diagrams" to determine the voltage, $V(z,t)$, and current, $I(z,t)$, variations on the line for $0 < z < l$ and $t > 0$ for $f(t) = \delta(t)$.

   b) Write your expressions for $V(\frac{l}{4}, t)$ and $I(\frac{l}{4}, t)$ as weighted sums of appropriately delayed impulses $\delta(t)$.

   c) Plot $V(\frac{l}{4}, t)$ as a function of t for $0 < t \leq 4\,\mu$s for $f(t) = 10u(t)$ V. — **Hint:** use the convolution of the result of part (b) with $10u(t)$.

   d) Determine the steady state voltage and current on the line for the excitation from part (c).

2. A generator with internal resistance $R_g = 50\,\Omega$ and an open circuit output voltage $f(t) = 90\delta(t)$ feeds a T.L. that has an unknown characteristic impedance Z_o and an unknown resistive load termination R_L at an unknown distance, L, from the generator. At a distance $z_0 = 300$ m from the generator, smaller than L, the voltage waveform as a function of time for $0 < t < 9\,\mu$s is found to be $V(z_0, t) = 60\delta(t-2) - 20\delta(t-4) + \frac{20}{3}\delta(t-8)$ V, which is plotted below.



   a) Determine the injection coefficient τ_g and the impedance of the transmission line, Z_o.

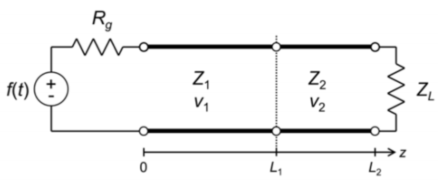
   b) Determine the load reflection coefficient Γ_L and the load resistance, R_L.

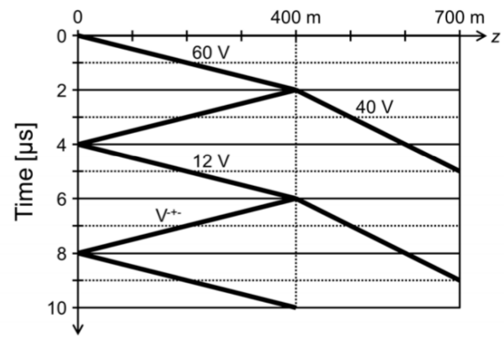
   c) Determine the transmission time, $T = L/v_p$, of the impulse propagating on the transmission line.

   d) Determine the speed of wave propagation on the line, v_p, in m/s and the length of the transmission line, L in meters.

   e) Determine the next two voltage impulses (magnitudes and time delays) that will be measured at z_0 on the line for $t > 9\,\mu$s.

3. A system of two transmission lines connected in series are driven by a voltage source $f_i(t) = V_0 u(t)$ and terminated by a resistive load of $60\,\Omega$ as shown in the figure below. A switch is closed at $t = 0$ and the positive voltages are measured for 10 μs giving the bounce diagram shown in the figure — the voltage values indicated in the diagram correspond to delta function weights times the source voltage V_o, products such as $V_o\tau_g$, $V_o\tau_g(1+\Gamma_{12})$, etc.





The impedance and transmission time of line 1 are Z_1 and T_1 and those of line 2 are Z_2 and T_2. Using the figures, identify the following parameters in appropriate units:

a) Propagation velocity v_{p1} on line 1, and propagation velocity v_{p2} on line 2

b) Impedance Z_2

c) Reflection coefficient Γ_{12} between lines 1 and 2

d) Impedance Z_1

e) Source resistance R_g

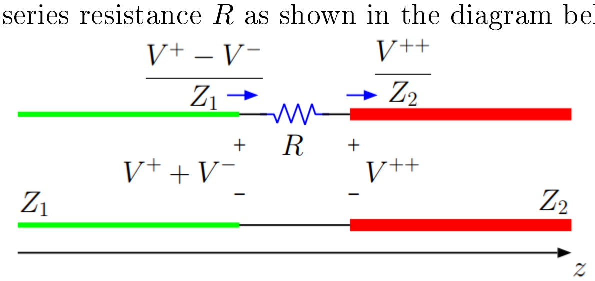
f) Source voltage V_o

g) Reflected voltage V^{-+-} on line 1 (see the diagram for this notation)

h) Steady state voltage V_1 on line 1 as $t \to \infty$

i) Steady state voltage V_2 on line 2 as $t \to \infty$

4. Two T.L.'s with characteristic impedances Z_1 and Z_2 are joined at a junction that also includes a series resistance R as shown in the diagram below.

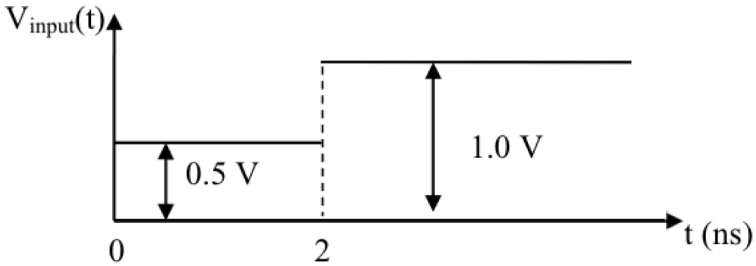


a) Write the pertinent KVL and KCL equations at the junction that relate $V^+(t - \frac{z}{v_{p1}})$, $V^-(t + \frac{z}{v_{p1}})$ and $V^{++}(t - \frac{z}{v_{p2}})$.

b) Solve the KVL and KCL equations above to obtain the reflection and transmission coefficients $\Gamma_{12} \equiv \frac{V^-}{V^+}$ and $\tau_{12} = \frac{V^{++}}{V^+}$ for the junction.

c) Calculate $\Gamma_{12} \equiv \frac{V^-}{V^+}$ and $\tau_{12} = \frac{V^{++}}{V^+}$ for $Z_1 = 100\,\Omega$, $Z_2 = 50\,\Omega$, and $R = 25\,\Omega$.

5. A defect in one of the wires of a transmission line manifests itself as an effective series resistance at a distance d from the input. The transmission line is lossless, of length 2 m, and propagation speed $v = 2 \times 10^8$ m/s. The load impedance is 100 Ohm. Given that the voltage response at the input of the line when a line is driven by a unit step voltage source with source impedance of 100 Ohm is as depicted in the figure below:



a) Calculate the characteristic impedance of the transmission line;

b) Calculate the distance d from the source where the defect occurs;

c) Calculate the defect resistance;

d) Plot the voltage response at the load.

6. Write two short paragraphs (100~150 words each) reflecting on your learning experience in ECE 329.

a) Paragraph 1 – Curiosity: Describe one topic from the course (such as transmission lines, plane waves, or impedance matching) that sparked your curiosity. Explain how you explored this topic beyond lecture material or how it changed your understanding of electromagnetic phenomena.

b) Paragraph 2 – Connections and Value: Discuss how this concept connects to real-world engineering applications (e.g., wireless communication, PCB design, or EMC compliance) and how mastering it helps engineers create value for society through innovation, efficiency, or reliability.