ECE 3317

Applied Electromagnetic Waves

Exam 1

Oct. 19, 2023

Name ____

General Information:

The exam is open-book and open-notes. You are not allowed to use any device that has communication functionality (laptop, cell phone, ipad, etc.).

Remember, you are bound by the UH Academic Honesty Policy during the exam!

Instructions:

- Show all of your work. No credit will be given if the work required to obtain the solutions is not shown.
- Write neatly. You will not be given credit for work that is not easily legible.
- Leave answers in terms of the parameters given in the problem.
- Show units in all of your final answers.
- Circle your final answers.
- Double-check your answers. For simpler problems, partial credit may not be given.
- If you have any questions, ask the instructor. You will not be given credit for work that is based on a wrong assumption.
- Make sure you sign the academic honesty statement below.

Academic Honesty Statement

By taking this exam, you agree to abide by the UH Academic Honesty Policy during this exam. You understand and agree that the punishment for violating this policy will be most severe, including getting an F in the class and getting expelled from the University.

Signature: ____

Problem 1 (35 pts)

A vertical (z-directed) wire antenna radiates a field along the surface of the earth in the x direction. Away from the antenna, the fields in the x direction are given in the phasor domain as

$$\underline{E}(x) = \underline{\hat{z}}\, E_0 \left(\frac{1}{x} + \frac{1}{jk_0 x^2} \right) e^{-jk_0 x} \quad \text{[V/m]},$$

$$\underline{H}(x) = -\underline{\hat{y}} E_0 \frac{1}{\eta_0} \left(\frac{1}{x} + \frac{1}{jk_0 x^2} \right) e^{-jk_0 x} \quad \text{[A/m]},$$

where

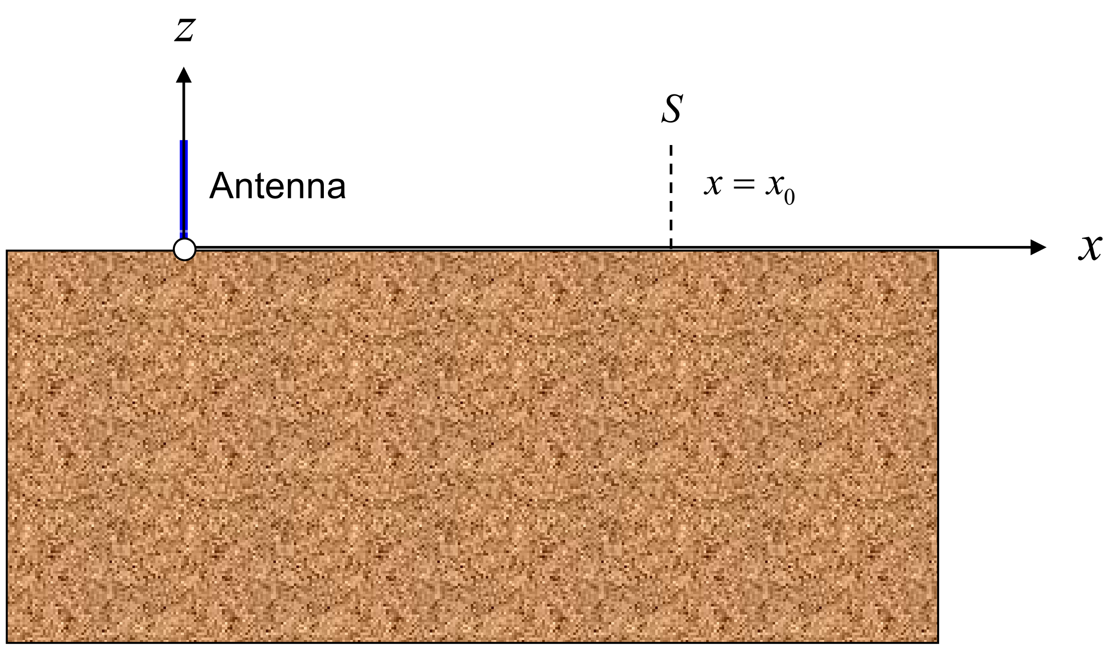
$\eta_0 = \sqrt{\mu_0 / \varepsilon_0}$ and $k_0 = \omega \sqrt{\mu_0 \varepsilon_0}$ are constants that are real.
(They are called the intrinsic impedance of free space and the wavenumber of free space.) The constant E_0 is an arbitrary complex number.

a) Find the electric field vector in the time domain at $x = x_0$.

b) Find the complex Poynting vector at $x = x_0$.

c) Find the complex power flowing (in the positive x direction) through a rectangular surface S that is perpendicular to the x axis and is one meter wide in the y direction and 2 meters tall in the z direction. The surface is located at $x = x_0$.

d) Find the watts crossing the surface S in the positive x direction.
e) Find the vars crossing the surface S in the positive x direction.



ROOM FOR WORK

ROOM FOR WORK

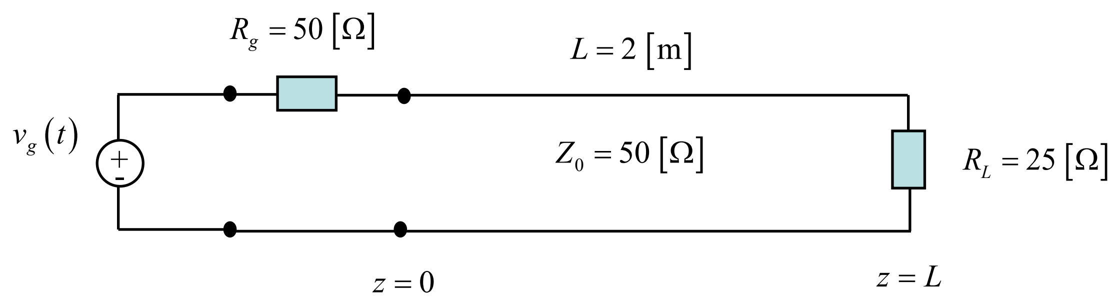
Problem 2 (30 pts)

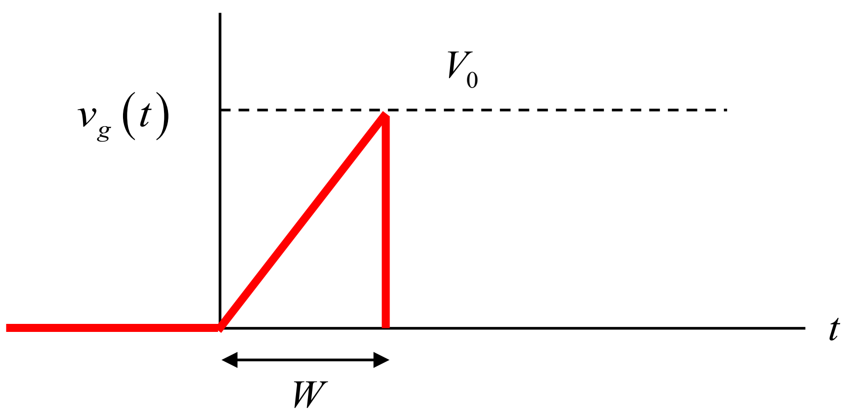
A voltage source is applied at the left end of a transmission line as shown below. A plot of the generator voltage $v_g(t)$ is shown below. The pulse peak is $V_0 = 4.0\,[\text{V}]$ and the width of the pulse is $W = 2.5\,[\text{ns}]$. The transmission line is filled with Teflon, having a relative permittivity of $\varepsilon_r = 2.25$.

a) Plot the voltage $v(t)$ measured by an oscilloscope that is connected to the line at z = 1.0 [m]. Plot to a time of 20 [ns].

b) Plot a snapshot of the voltage on the line at 5 [nS].

Use the graphs on the next page to make your plots. Label all important values of voltage, time, and distance on your plot, so that the pulse amplitude and the start and end times (or locations) of the waveform can be clearly seen.



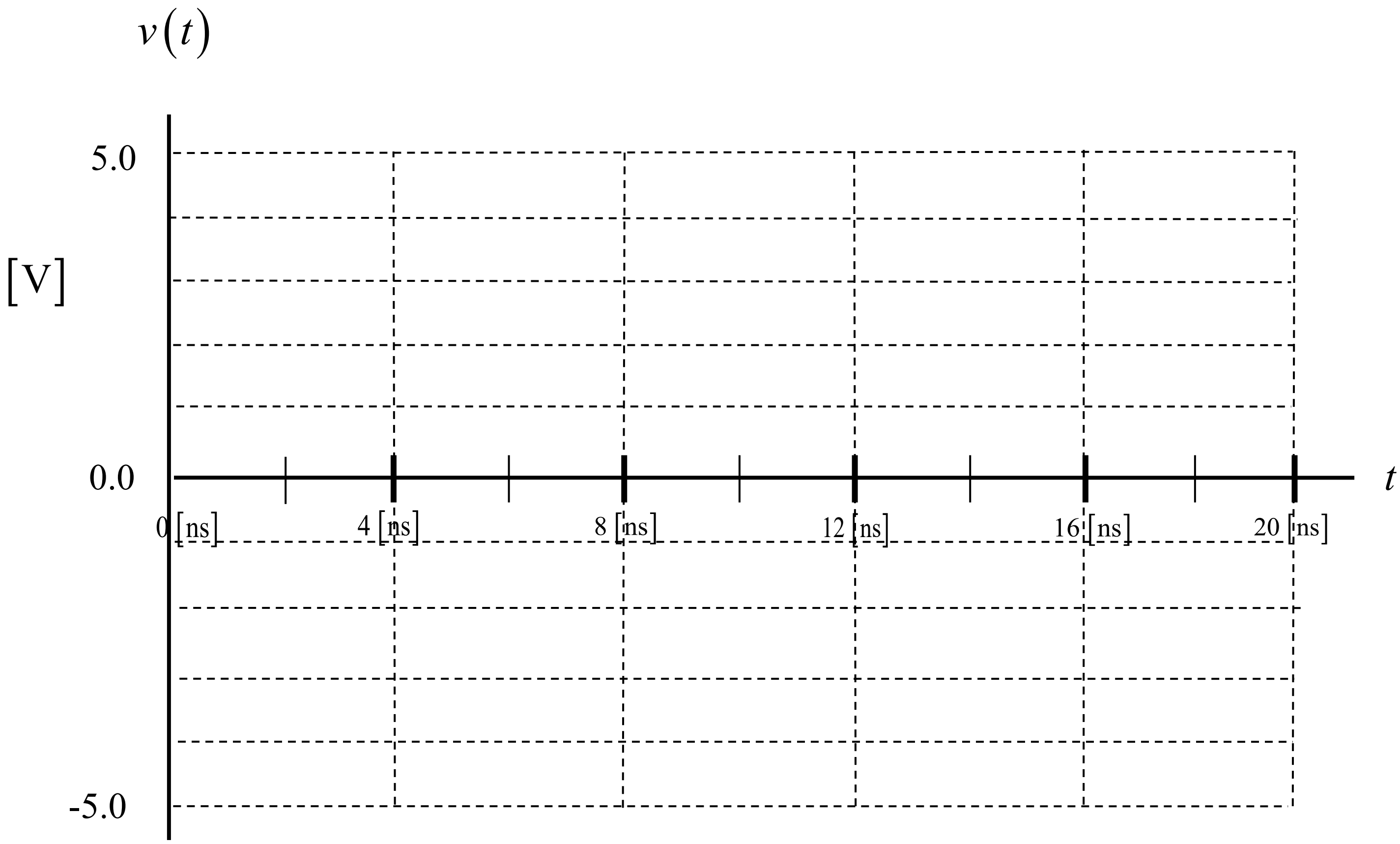


ROOM FOR WORK

(Please make your voltage plots on the next two pages.)

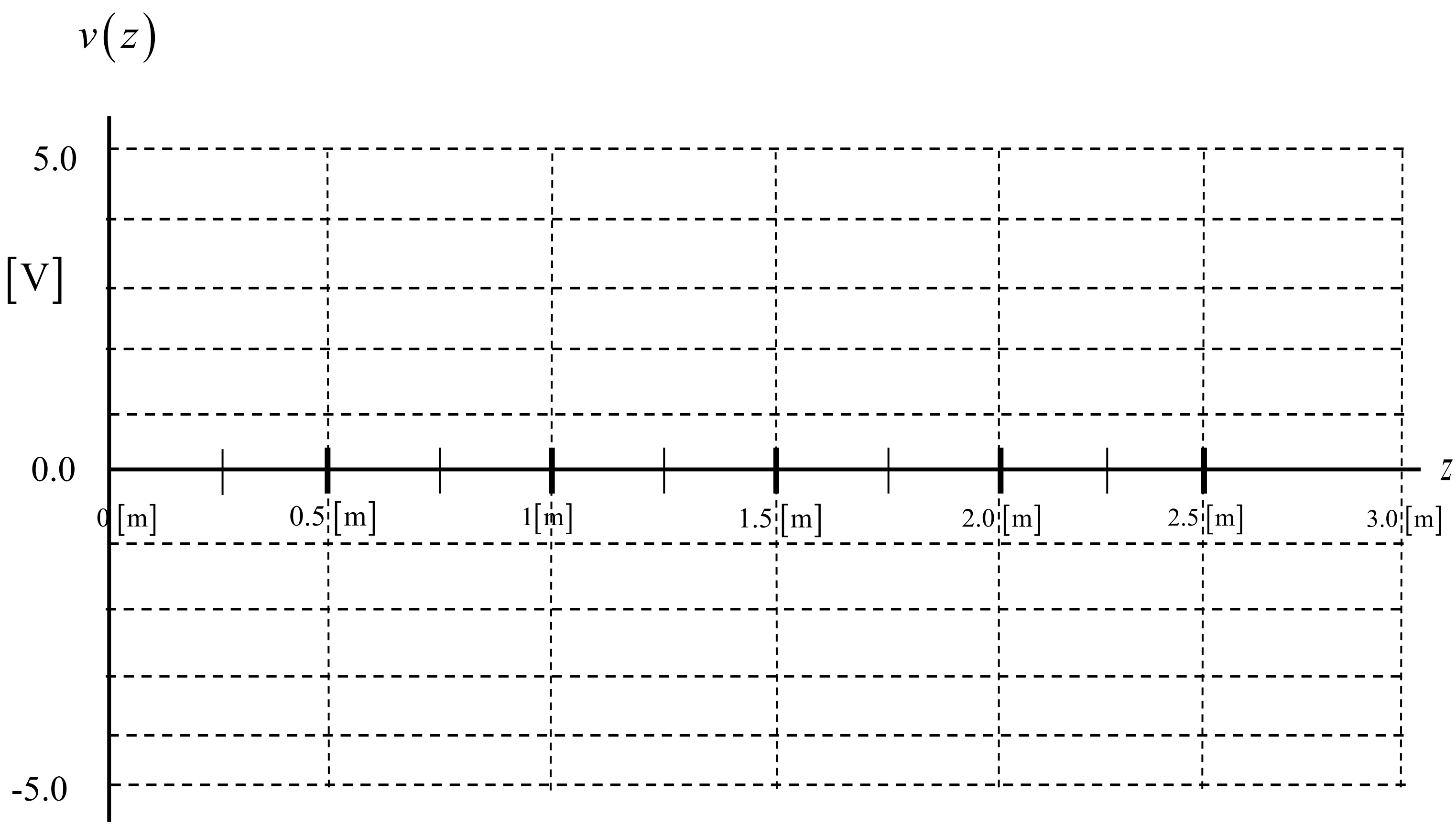
Make your plots here:

Part (a)



Make your plots here:

Part (b)



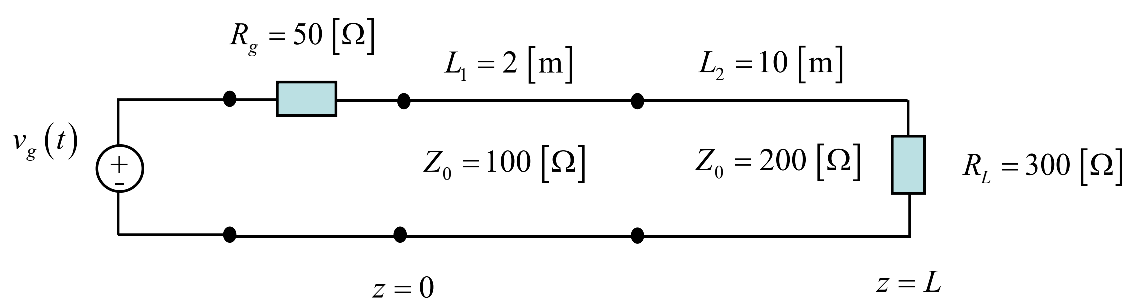
Problem 3 (30 pts)

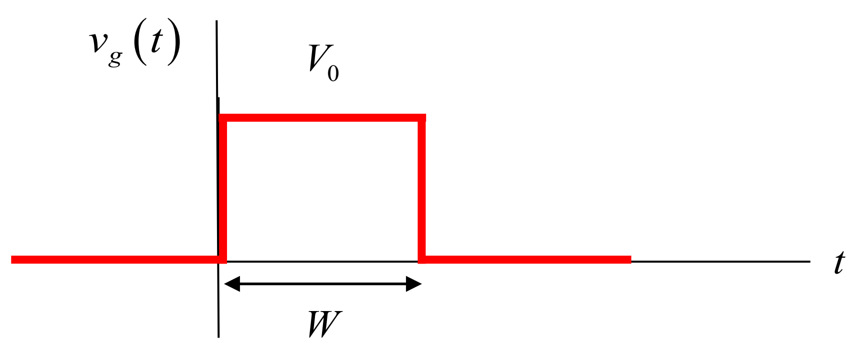
A voltage source is applied at the left end of a transmission line as shown below. The transmission line meets a second transmission line, which is then terminated by a load. Each line is filled with a dielectric material having $\varepsilon_r = 2.25$.

A plot of the generator voltage $v_g(t)$ is shown below. The pulse peak is $V_0 = 3\,[\text{V}]$ and the width of the pulse is $W = 2\,[\text{ns}]$.

(a) Make a bounce diagram for this problem, for the left line. Plot to a time of 40 [ns]. Put your bounce diagram on the next page.

(b) Plot the voltage $v(t)$ measured by an oscilloscope that is connected to the first (left) line at a point halfway down the first line (halfway between the generator and the junction). Plot to a time of 20 [ns]. Please use the graph on the page after the bounce diagram to make your voltage plot. Label all important voltage values and important times (start and end times of all pulses) on your plot.





ROOM FOR WORK

(Please make your bounce diagram and voltage plot on the next pages.)

Make your bounce diagram here:

Make your voltage plot here: