Fields and Waves I

Name _____ ECSE-2100 Fall 1999 Section (The Only One)

Preparation Assignments for Homework #7

Due at the start of class.

Reading Assignments

Please see the handouts for each lesson for the reading assignments.

29 November Lesson 5.3 and 5.4

1. Is seawater a good dielectric or a good conductor at a frequency f = 1MHz?

2. If an electromagnetic wave is propagating in the +y direction and the magnetic field of this wave is in the +x direction, what is the direction of the electric field of this wave?

Class time 1 December (Note the date – Wednesday)

Open shop to work on Homework 7. Due at 5 pm on 1 December.

Fields and Waves I

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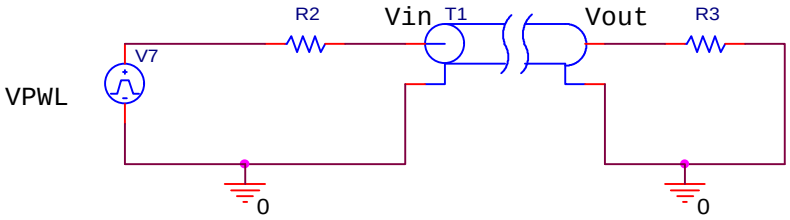
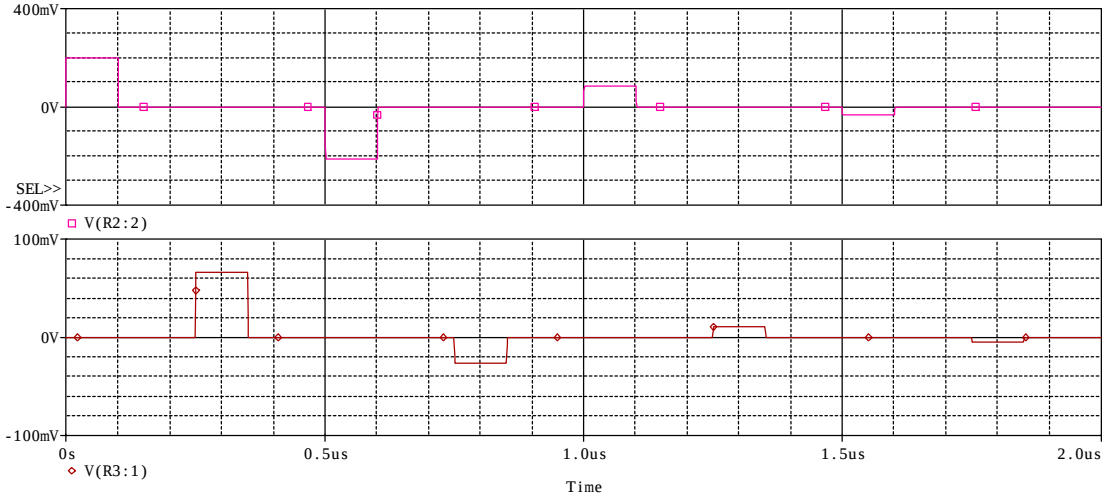
Homework #7

Problem 1. (10 Points) **Pulses on Transmission Lines**

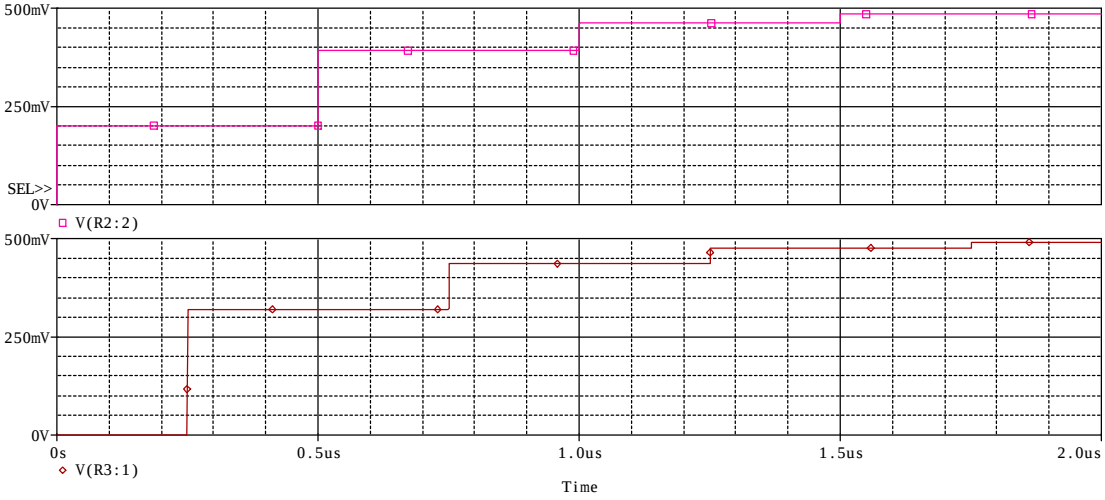


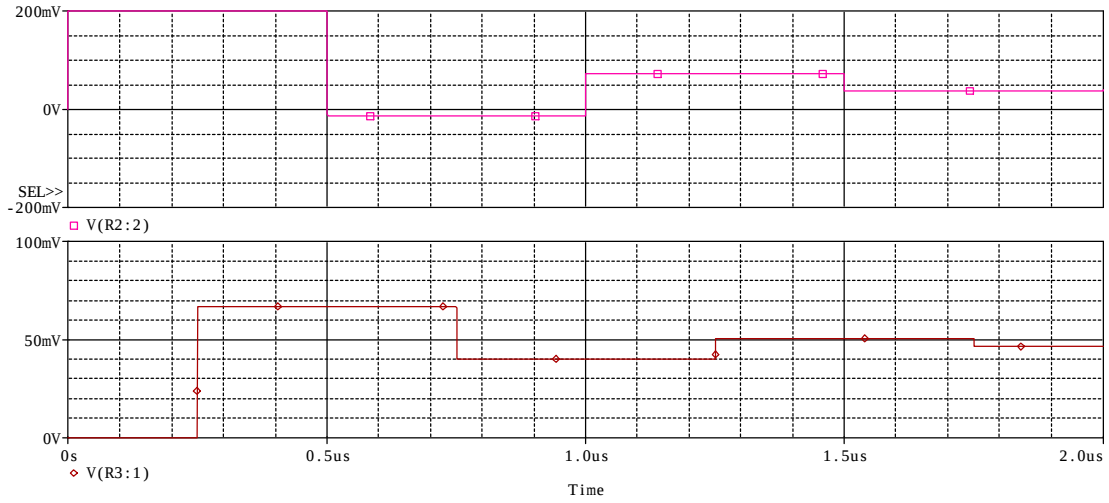
The transmission line configuration shown above is analyzed and the input and output voltages of the line displayed below.



a. Determine the magnitude and duration of the input pulse V7 (if it was measured before the resistor R2), the resistances R2 and R3, and the length of the line. The transmission line has a characteristic impedance of 50Ω and a velocity factor of 67%.

b. Now assume that the pulsed source is replaced by a DC voltage that is switched on at time t = 0. Which of the following 2 plots would be observed at the input and output of the line? Explain your answer.





c. For both sources, when and where does the maximum voltage appear on the transmission line?

Problem 2. (10 Points) **Electromagnetic Waves**

The electric field of a plane wave propagating in a lossless medium is given to within the constant E_m by the expression $\vec{E} = E_m\left(0.5\hat{a}_x + 0.5\hat{a}_y\right)\cos\left(-\frac{10^2}{\sqrt{2}}x + \frac{10^2}{\sqrt{2}}z + 1.54\times 10^{10}t\right)$

a. In what part of the electromagnetic spectrum is this wave (light, x-rays, microwaves, radio, etc.)?

b. Write this field and its corresponding magnetic field in phasor form.

c. What direction is this wave traveling? Draw a diagram showing the direction of propagation of the wave and the directions of its electric and magnetic field vectors.

d. Assuming that the material this wave is propagating in is only electric ($\mu=\mu_o$), what is the value of the dielectric constant ε_r of this material? What material do you think it might be?

e. If the average power per unit area is 100 watts/m^2, determine the value of E_m.

f. Now assume that this wave propagates in the z direction. Rewrite the electric field of this wave in phasor form and in time-domain form. Plot the time domain form of the electric field as a function of z at time t = 0.

g. Finally, assume that this same wave is propagating in the z direction in seawater. Since the wave magnitude will now decay as a function of time, assume that the magnitude is the same at z = 0 as a reference. Write the phasor and time-domain expressions for the electric field of this wave. Plot the time-domain form of the electric field as a function of z at time t = 0.