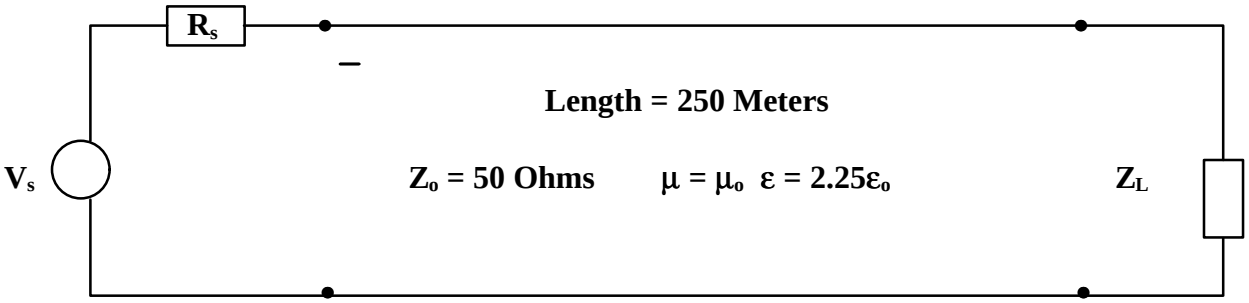
Fields and Waves I

Name _____ ECSE-2100 Spring 1999 Section _____

Homework #7
Pulses on Transmission Lines, Plane Waves
Due at 5pm on 16 April

Problem 1 (10 points) Pulses on Transmission Lines



a. Assume that $V_s(t)$ is a one microsecond pulse of amplitude 1 volt, R_s = 50 Ohms and that Z_L = 50 Ohms. Determine and plot the voltage as a function of time at the load. To do this and subsequent parts of this problem, you should generate a lattice diagram for each case. Also, you should determine the voltage for a time period that is long enough to show all pulses of significant amplitude. You will have to define what is significant. What is the maximum pulse height observed anywhere on the transmission line. When does this occur?

b. Change the load to 100 Ohms. Determine and plot the voltage as a function of time at the load. Where and when does the maximum voltage occur on the transmission line? What is its value?

c. Change the source impedance to 25 Ohms. Determine and plot the voltage as a function of time at the load. Where and when does the maximum voltage occur on the transmission line? What is its value?

d. Replace the source with a 1.5 volt battery and a switch. Assume that the internal impedance of the battery is negligible. Keep the load impedance at 100 Ohms. Determine the voltage at both the source and the load as a function of time. Assume that the switch is closed at t = 0. How long does it take for the load voltage to achieve a value within 1% of the battery voltage? What is the maximum voltage observed anywhere on the transmission line?

Problem 2 (10 points) Plane Waves

The electric field of a wave is given (in time domain form) as $\mathbf{E}(t) = E_o \cos(3.5\text{x}10^{15}t + 1.17\text{x}10^{7}z)\mathbf{a}_x$.

a. In what part of the electromagnetic spectrum (radio, μwave, visible light, X-ray, …) is this wave?

b. What direction is this wave traveling?

c. What is $\mathbf{H}(t)$ in time domain form? Your answer will contain E_o, since we have not determined its value yet.

d. Write both **E** and **H** in phasor form.

e. Assume that the average power per unit area of this wave is about 1kw per square meter. Determine the magnitudes of the electric and magnetic fields.

f. What material is the wave propagating in?

g. Assume you are trying to weld something with a CO_2 laser beam (Prof. Connor had this done to his retina). What kind of power density is necessary to do a job like this? Compare the value of the electric field intensity of this wave with the field that will cause air to breakdown.