ELEN 3401 Electromagnetics
Problem Set #1

<u>DUE: Friday February 7</u> (Please include your name and UNI on the assignment)

Problem 1: Traveling Waves

Consider two sinusoidal waves given by the following functions:

$$E_1(z,t) = E_0 \cos\left(10t - 20z + \frac{\pi}{2}\right)$$

$$E_2(z,t) = -E_0 \cos\left(10t + 20z + \frac{\pi}{3}\right)$$

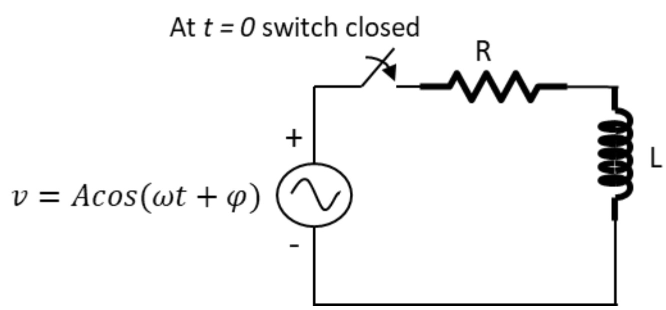
a. Determine the direction of propagation and phase velocity for each of the two waves.

b. Show that both waves satisfy the wave equation.

c. Find the *z* locations where the waves interfere constructively and destructively (where their superposition is maximal and minimal) at $t = \pi/20$ s.

Problem 2: Linear System – Time and Phasor Domain

Consider the simple circuit shown in the diagram below with a resistor *R* and an inductor *L* in series with a voltage source: $v(t) = Acos(\omega t + \varphi)$ and a switch. Initially the switch is open. At *t=0*, the switch is closed.

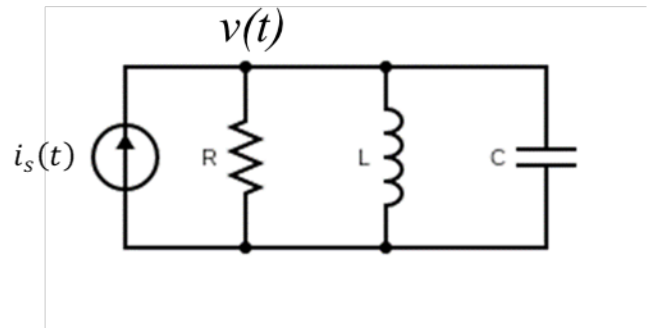


a. Write the differential equation governing the behavior of the current *i(t)* through the circuit for *t > 0.*
b. Develop a solution to this differential equation in the time domain. Make an attempt toward obtaining an expression for *i(t)* for all time. You may not be able to obtain the complete solution – please show all your work in the process.
c. For the same circuit and conditions, obtain the phasor expression for the current.
d. Solve this equation for the phasor current.
e. Transform back to the time function for the current *i(t).*
f. Comment on the methodology of the time domain versus using the phasor domain to obtain the solution to this linear system.

Problem 3: Circuit Analysis using the Phasor Domain

Consider a parallel *RLC* circuit shown in the figure below and driven by the current source:

$$i_s(t) = I_0 \cos\left(\omega t + \frac{\pi}{3}\right) \text{ A}$$



a. Obtain the equation for $v(t)$ in terms of R, L, C, and $i_s(t)$.

b. Convert this differential equation to the phasor domain.

c. Solve the equation for **V**, the steady-state phasor voltage across each component.

d. Using the phasor domain analysis obtain the full time domain expression $v(t)$.

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