ASSIGNMENT 2

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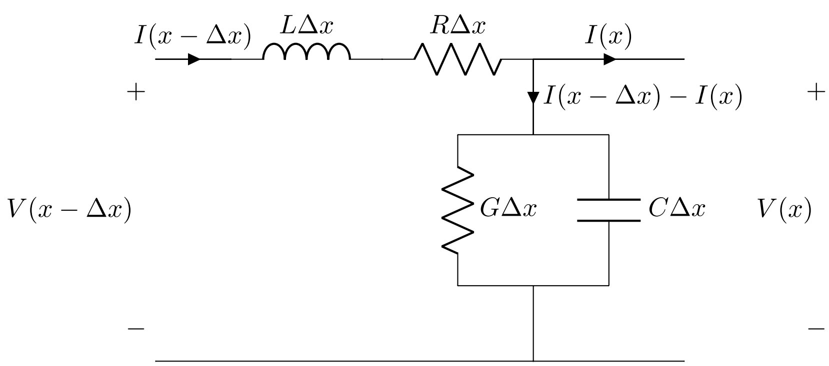
Problem 1



By KVL.

$$V(s,x-\Delta x) = (sL+R)\,\Delta x I(s,x-\Delta x) + V(s,x) \tag{1}$$

$$\implies \frac{V(s,x-\Delta x)-V(s,x)}{\Delta x} = (sL+R)\,I(s,x-\Delta x) \tag{2}$$

As $\Delta x -> 0$,

$$\frac{\partial V(x)}{\partial x} = (j\omega L+R)\,I(x) \tag{3}$$

By KCL,

$$V(s,x) = \frac{I(s,x-\Delta x)-I(s,x)}{(G+sC)\Delta x} \tag{4}$$

As $\Delta x -> 0$,

$$\frac{\partial I(x)}{\partial x} = (j\omega C+G)\,V(x) \tag{5}$$

From equation (3) and (5), we deduce that,

$$\frac{\partial^2 V(x)}{\partial x^2} = (j\omega L+R)\,(j\omega C+G)\,V(x) \tag{6}$$

$$\frac{\partial^2 I(x)}{\partial x^2} = (j\omega L+R)\,(j\omega C+G)\,I(x) \tag{7}$$

Comparing this with a travelling wave equation we get that,

$$\gamma = \sqrt{(j\omega L+R)\,(j\omega C+G)} \tag{8}$$

Solution are,

$$V(x) = V^{+}e^{-\gamma x} + V^{-}e^{\gamma x} \tag{9}$$

$$I(x) = \frac{V^{-}e^{\gamma x} - V^{+}e^{-\gamma x}}{Z_0} \tag{10}$$

Where $Z_0 = \frac{(j\omega L+R)}{(j\omega C+G)}$

Problem 2

$$z(t) = x(t)cos(\omega t) + y(t)sin(\omega t) \tag{11}$$

$$z(t) = \sqrt{x^2(t)+y^2(t)}\left(\frac{x(t)}{\sqrt{x^2(t)+y^2(t)}}cos(\omega t) + \frac{y(t)}{\sqrt{x^2(t)+y^2(t)}}sin(\omega t)\right) \tag{12}$$

$$z(t) = \sqrt{x^2(t)+y^2(t)}cos(\omega t - tan^{-1}\left(\frac{y(t)}{x(t)}\right)) \tag{13}$$

$$\implies A(t) = \sqrt{x^2(t)+y^2(t)} \tag{14}$$

$$\implies \phi(t) = -tan^{-1}\left(\frac{y(t)}{x(t)}\right) \tag{15}$$

We cannot comment on the bandwidth of A(t) and ϕ(t) compared to x(t) and y(t).
Say x(t) is m(t)sin(ω_0t) and y(t) is m(t)cos(ω_0t) then we can tell that A(t) = m(t) thus band-limited less than both x(t) and y(t) and ϕ(t) is linear which means band-unlimited take the case where x(t) = y(t) here Phase is constant and thus band-limited.