Exercises on LTI circuits

In the exercises that follow, the circuits will be considered linear systems and Time invariant:

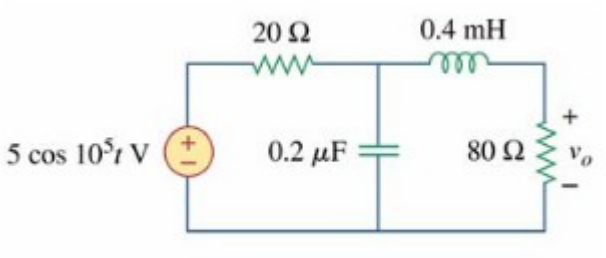
1. State why they are linear

2. Indicate which set of conditions is sufficient to consider them time invariant

3. Discuss if it is possible/appropriate to use the impulse response and the convolution to solve the exercises.

4. Indicate two characteristics that make the representation with complex exponentials adequate for their resolution.

Exercise 1



1. Calculate the output $v_0(t)$
   a. Indicate the procedure and the phasors you use
   b. Indicate the signs of voltages and currents
   c. Express the Kirchhoff equations
   d. Indicate the current phasor in the coil and it signal in time

2. Change the input phase by $\pi/3$ and calculate the output

3. Delay the input signal by T= 3 sec and calculate the output

4. Change the input to $v_0(t)=2\cos(10\pi t-\pi/3)-4\,sen(2\pi t+1.2)$ and calculate the output

5. Change the input to $v_0(t)=\cos(wt)$ and calculate the output

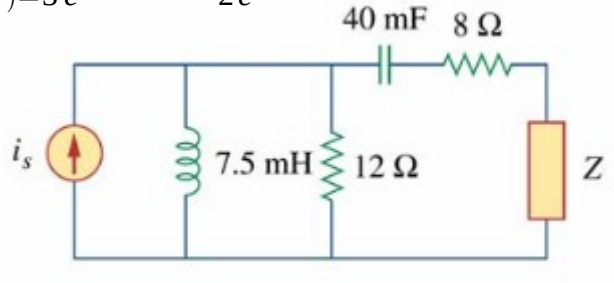
6. Calculate the power signal of the inductor with the input given in Point 1.

7. Calculate the power signal of the inductor with the input given in Point 2.

8. Calculate the average power in the output resistance, with the input given in Point 5. Discuss if it behaves like a filter.

Exercise 2

$i_s(t)=3e^{j2\pi 10^3 t-0.5}-2e^{j2\pi 10 t-0.5}$



1. Calculate the voltage output $v_0(t)$ at Z (an inductor with L=3.2 mH)
   a. Indicate the procedure and the phasors you use
   b. Indicate the signs of voltages and currents
   c. Express the Kirchhoff equations
   d. Indicate the current phasor in the coil and it signal in time

2. Change the input phase by $\pi/3$ and calculate the output

3. Delay the input signal by T= 13 sec and calculate the output

4. Change the input to $i_s(t)=2\cos(10\pi t-\pi/3)-4\,sen(2\pi t+1.2)$ and calculate the output

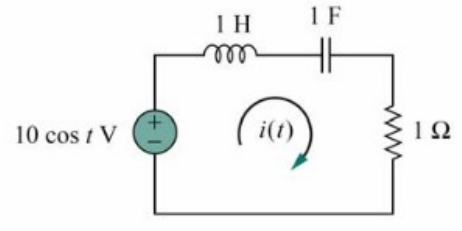
5. Change the input to $i_s(t)=\cos(wt)$ and calculate the output

6. Calculate the power signal of the inductor with the input given in Point 1.

7. Calculate the power signal of the inductor with the input given in Point 2.

8. Calculate the average power in the output resistance, with the input given in Point 5. Discuss if it behaves like a filter.

Exercise 3



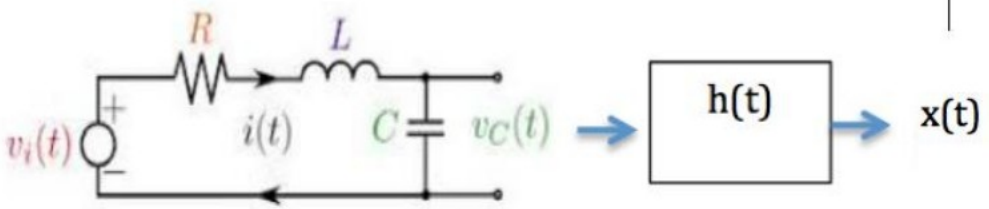
1. Identify all possible systems in this circuit considering voltage as input

2. Analyze all the systems in the previous point for a frequency *f*.

3.Indicate what type of filter is each of the previously identified systems

Exercise 4

Consider the Linear and Time Invariant (LTI) system with input vi (t) and output x (t) of the figure below. The values of the elements of the circuit are R = 1Ω, L = 1 H, C = 1 F (consider all voltages in volts and currents in amps).

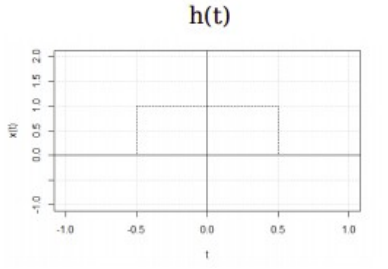


1. Classify the filters that form the voltage signals in the resistor and in the coil, taking the generator voltage as input in both cases.

For the rest of the questions, $v_i(t) = sen\left(2\pi t - \frac{\pi}{3}\right) - 2\cos(2\pi t) + \cos(\pi(t-2)) + \cos(50\pi t - \pi/3)$

2. Calculate $v_C(t)$

3. For the h (t) in the figure below, specify the output x (t) leaving the constants of the functions as symbols, without specifying their numeric value.



4. Calculate h (t) so that the output x (t) does not contain the frequency ω = 2.

5. Calculate x (t) for the assumption in the previous point.