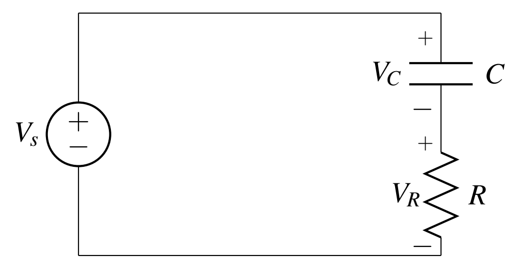
EECS 16B Designing Information Devices and Systems II
Spring 2016 Anant Sahai and Michel Maharbiz **Discussion 7A**

1. Warm-up: RC filter

To understand the concept of transfer functions and filters with a concrete example, consider the following simple RC circuit. Let the voltage source V_S be designated as the input phasor, and let V_R and V_C designate the two output voltage phasors.



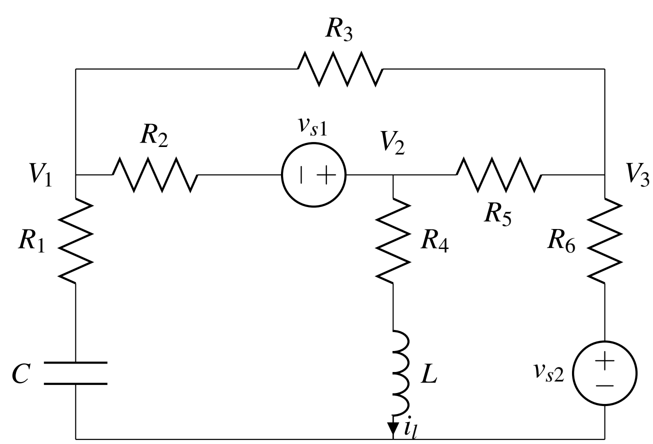
(a) In lecture, you learned the transfer function from V_s to V_C for the capacitor. Now use a similar phasor analysis for this circuit to find the transfer function from V_s to the output voltage V_R across the resistor.

(b) For the transfer function you found, write it in the form $|H(\omega)|e^{j\phi(\omega)}$, where $|H(\omega)|$ is the magnitude and $\phi(\omega)$ the phase angle.

(c) Draw plots for the magnitude and angle of the transfer function as the frequency ω varies. Is this filter high pass (prefers to pass through high frequencies), low pass (prefers to pass through low frequencies), or band pass (prefers some frequency range in the middle — not low frequencies and not high ones either)?

2. Phasor analysis

The analysis techniques you learned previously for resistive circuits are equally applicable for analyzing AC circuits in the phasor domain. In this problem, you will work through the steps of phasor analysis with a concrete example. Consider the circuit below.



The components in this circuit are given by:

$$R_1 = 3\ \Omega,\ R_2 = R_3 = R_4 = R_5 = R_6 = 2\ \Omega$$

$$C = 0.25\text{ mF}, \quad L = 1\text{ mH}$$

and the voltage sources (in volts) are

$$v_{s1}(t) = 12\cos\left(10^3 t\right)$$

$$v_{s2}(t) = 6\sin\left(10^3 t\right)$$

(a) **Step 1:** Transform all the components and sources into phasor domain.

(b) **Step 2:** Perform circuit analysis in the phasor domain, and write out equations for V_1, V_2, and V_3. (Please define the current direction as positive $+$ if it is going out of a node.)

(c) **Step 3:** Cast the equations you find out into matrix form. You don't have to solve this matrix equation, simply propose a method to obtain V_1, V_2, V_3.

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