Electric Circuits II

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Project 1: Passive Filter Design

The circuit below

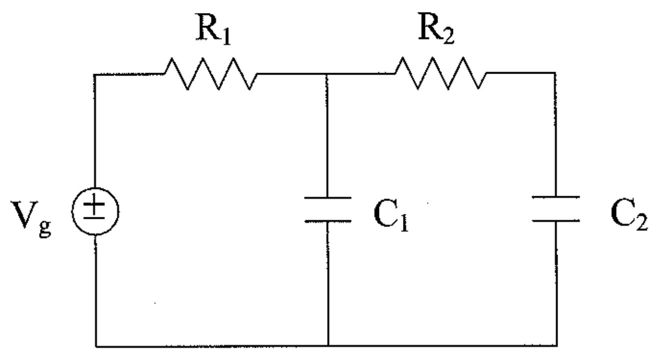

Fig. 1. A passive filter.

it driven by a sinusoidal voltage source of the form $v_g(t) = \cos \omega t$.

Problem 1. Derive an expression for the transfer function

$$H(j\omega) \equiv \frac{\vec{V}_{C_2}}{\vec{V}_g} \tag{1}$$

in terms of R_1, R_2, C_1, C_2 and ω.

Problem 2. Choose physically realistic values for R_1, R_2, C_1 and C_2 so that $H(j\omega)$ has the form

$$H(j\omega) = \frac{1}{(1 + j\omega/a)(1 + j\omega/b)} \tag{2}$$

where $a = 3,000$ and $b = 20,000$. Show all your work!

Problem 3. Write an m-file that solves the circuit in Fig. 1 for different frequencies. Then, plot $20 \log |H(j\omega)|$ for the element values obtained in Problem 2. Compare the obtained curve with the Bode plot of the desired transfer function, and verify that the design requirements have been met.

Problem 4. Perform an AC analysis of your circuit in SPICE, and compare with the results obtained using Matlab.

Problem 5. Write an m-file that generates plots of $20 \log |H(j\omega)|$ for random variations in the element values (assuming 20% tolerances). Plot the curves that you obtained on a *single* graph.

Problem 6. Assemble the designed circuit and measure $|H(j\omega)|$ for a range of relevant frequencies. Use the data to plot $20 \log |H(j\omega)|$ in Matlab, and compare this with your simulation results.