ELEN 118
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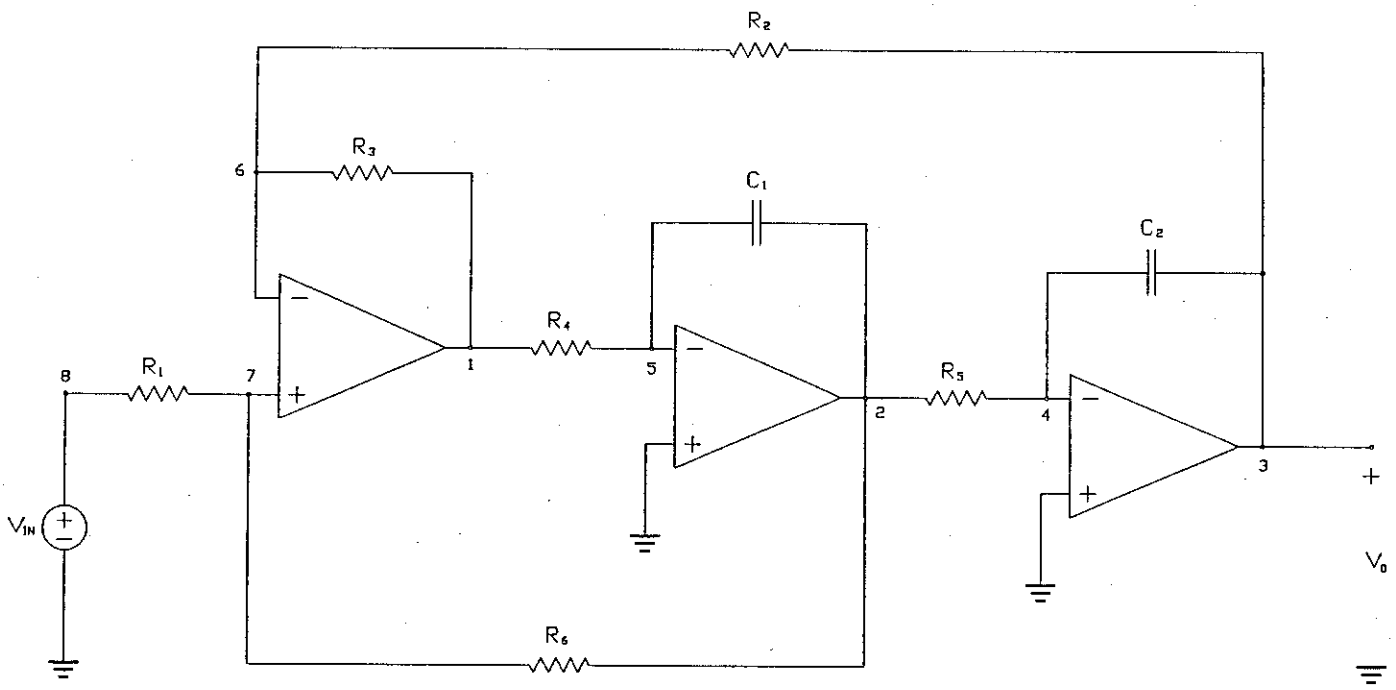
PROJECT # 2: AC Simulation of Active Filters

The circuit below can be used to design *three* different types of filters; the specific filter characteristics will depend on whether the output voltage is taken from node 1, 2 or 3.



The element values in this circuit are:

$R_1 = R_2 = R_3 = R_4 = R_5 = 1K$; $R_6 = 9K$; $C_1 = C_2 = 50\ \mu F$.

PROBLEM 1.

Formulate the circuit equations for AC analysis. Indicate matrices *G*, *C* and vector *w* explicitly.

PROBLEM 2.

Create an m-file that will calculate the complex voltages in the circuit at different frequencies. The *input arguments* for this function should be matrices G and C, vector w and a vector z which consists of all the frequencies which are of interest. The *output arguments* should be the voltage magnitudes and phase angles at different frequencies. In other words your function should look something like: **[mag, phase] = bode1(*G, C, w, z*)**.

PROBLEM 3.

a) Use the function you created in Problem 2 to compute the magnitude and phase angle for voltages $\mathbf{V}_1$, $\mathbf{V}_2$ and $\mathbf{V}_3$. Vector z should contain frequencies ranging from 0.1 Hz to 1kHz (ten points per decade should suffice).

b) Obtain separate plots for the *magnitudes* of voltages $\mathbf{V}_1$, $\mathbf{V}_2$ and $\mathbf{V}_3$. The voltage magnitudes should be in *decibels*, and a semilog scale should be used (function ***semilogx*** **(*z, A*)** in Matlab).

c) Based on the plots obtained in part b), determine what types of filters are realized when the output voltage is taken from nodes 1, 2 and 3, respectively.

d) Obtain separate plots for the *phase angles* of voltages $\mathbf{V}_1$, $\mathbf{V}_2$ and $\mathbf{V}_3$. As in part b), use a semilog scale, and display the phase angles in *radians*.

PROBLEM 4.

a) Perform an AC analysis of this circuit in SPICE. Print out your *input file*.

b) Obtain separate *magnitude plots* for voltages $\mathbf{V}_1$, $\mathbf{V}_2$ and $\mathbf{V}_3$ in SPICE.

c) Obtain separate *phase plots* for voltages $\mathbf{V}_1$, $\mathbf{V}_2$ and $\mathbf{V}_3$ in SPICE.

d) Compare the results of your program with those of SPICE.