GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

Course ECE 2040

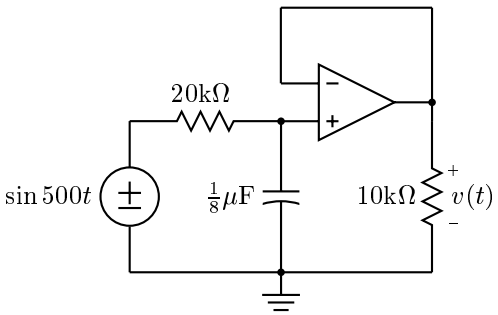
Circuit Analysis

Assigned: March 31, 2000
Due: April 7, 2000

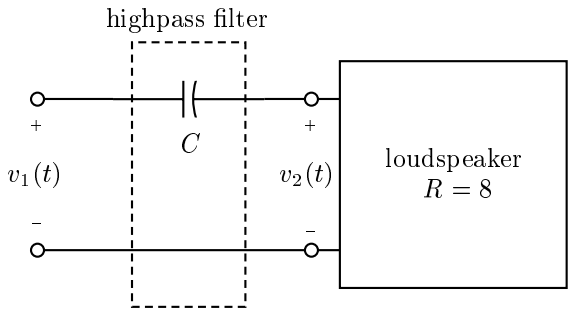
Problem Set #11

Reading: Read the following sections from the class notes:
Chapter 8, Sections 8.3.3, 8.3.4
Chapter 9, Sections 9.2.2, 9.3
Reading: Read the following sections from Irwin and Wu:
Chapter 8, Sections 8.8
Chapter 12, 12.1
Chapter 14, 14.5

Problem 11.1: For the circuit below find $v(t)$.



Problem 11.2: Many loudspeaker systems consist of two loudspeakers: the woofer, which reproduces the low frequency part of the signal, and the tweeter, which reproduces the high frequency part of the signal. A crossover network is used to select the high frequency part of the signal and feed it into the tweeter. Such a network functions as a highpass filter. The entire audio signal is applied at the terminals $a - a'$.



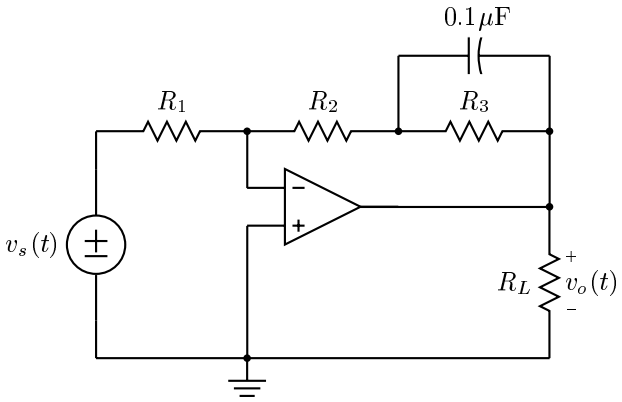
(a) Assuming that the equivalent circuit for the tweeter consists of just a resistor with a resistance of R, plot the pole-zero pattern of the system function that relates $v_2(t)$ to $v_1(t)$ and sketch the frequency response curves (magnitude and angle).

(b) If $R = 8\Omega$, find the value of the capacitance C so that the half-power frequency of the highpass filter is 5 kHz ($= 2\pi(5000)$ rad/s).

Problem 11.3: In the circuit below the value of R_1 is 10kΩ.

(a) Determine the values of R_2 and R_3 so that the gain (magnitude of the frequency response) at low frequencies is 5 and the gain at high frequencies is 2.

(b) Determine the frequency at which the gain is midway between these two values, i.e. the frequency at which the gain is 3.5.



Problem 11.4: A circuit has the system function

$$H(s) = \frac{s^2 + b^2}{(s+a)^2 + b^2}$$

where $b >> a$.

(a) Draw the pole-zero plot. Clearly label the locations of the poles and zeros on your plots.

(b) Sketch the magnitude of the frequency response of the filter.

Problem 11.5: An oscillator is a circuit whose system function has a pair of complex conjugate poles located on the $j\omega$-axis in the s-plane. It is capable of supporting a sustained oscillation, i.e., once started it will continue to produce a sinusoidal output $v_{out}(t)$. In the network below determine the value of K for which the system will oscillate and determine the frequency of oscillation.