ELEC 243
Problem Set 9
Homework Section
Due: March 27, 2015

H9.1 The circuit below is a resonant *bandpass filter*. It blocks low and high frequencies and passes a narrow band of frequencies.

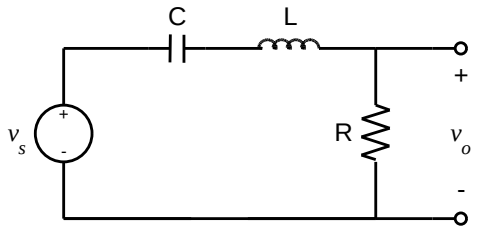
(a) Find the transfer function for this circuit.

(b) ω_0 is the *center frequency*, defined as the frequency at which the magnitude of the transfer function is a maximum. Show that $\omega_0 = 1/\sqrt{LC}$.

(c) ω_{LO} and ω_{HI} are the lower and upper *cutoff frequencies*, where the magnitude of the transfer function is 3 dB below its maximum value. The bandwidth is the distance between these two frequencies, i.e. $BW = \omega_{HI} - \omega_{LO}$. Show that $BW = \omega_0/Q$.

(d) For $C = 1\mu$F, find the values of L and R so that the filter has a center frequency of 1000 Hz and a bandwidth of 100 Hz.

(e) Sketch the magnitude and phase of the frequency response, indicating all important values.



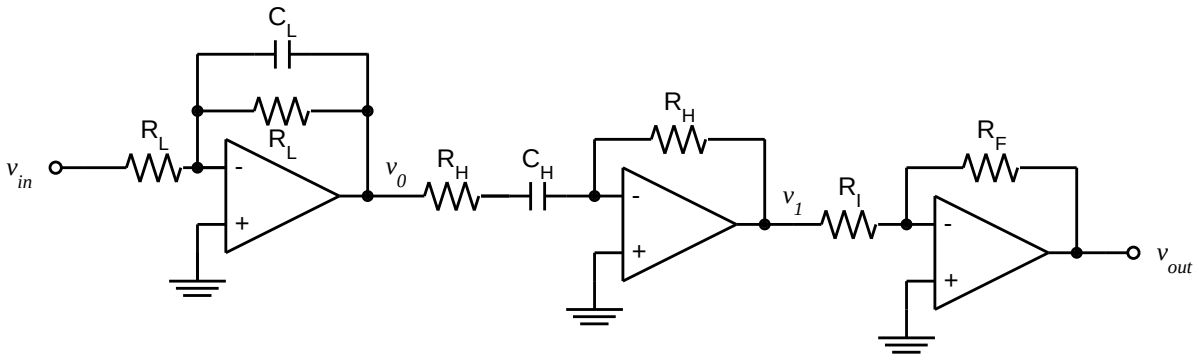
H9.2 The circuit below is a *broadband* bandpass filter. It consists of a cascade of three stages: 1) a unity-gain low-pass filter with cutoff frequency ω_2, which determines the upper edge of the pass band; 2) a unity-gain high-pass filter with cutoff frequency ω_1, which determines the lower edge of the pass band; and 3) a gain component which provides the desired level of gain in the passband. If we assume that $\omega_2 \gg \omega_1$, then the magnitude of the high-pass filter will be approximately one at the cutoff frequency of the low-pass filter (ω_2) and vice versa. This means that the cutoff frequencies of the bandpass filter will be approximately the same as those of the individual sections and we may design each stage independently.

(a) Draw a block diagram showing each stage as a separate block.

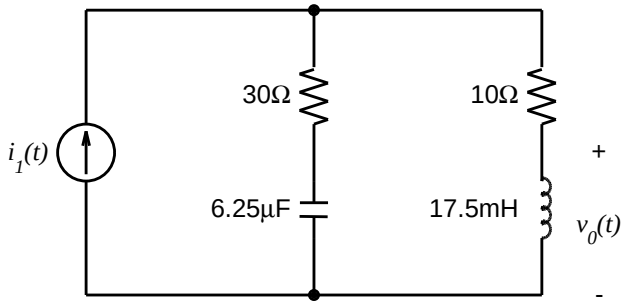
(b) Find the transfer function of each block.

(c) Determine the overall transfer function of the entire circuit and express as a ratio of polynomials in $j\omega$.

(d) Using a value of 0.2 μF for both capacitors, choose values for the resistors which will give a passband of 100 Hz to 10,000 Hz and a passband gain of 2.



H9.3 Find the sinusoidal steady-state expression for $v_0(t)$ in the circuit below if $i_1(t) = 0.8\cos(4000t)$A.



H9.4 Find the transfer function $\mathbf{H}(j\omega) = \dfrac{\mathbf{V}_0}{\mathbf{V}_1}(j\omega)$ for the following circuit. Simplify your result to a ratio of polynomials in $j\omega$. Sketch the magnitude of the frequency response, assuming $R_1 = 3R_2$.