ECE 211 Analog Discovery Lab #4

In this lab you will build a band pass filter by cascading 2 first order filters. The gain on the filters will be 1 and the cutoff frequencies 1k r/s and 10k r/s.

The design process begins with a transfer functions:

$$\text{HPF: } H(s) = K_2 s / (s + \alpha) \qquad \text{and} \qquad \text{LPF: } H(s) = K_1 / (s + \alpha)$$

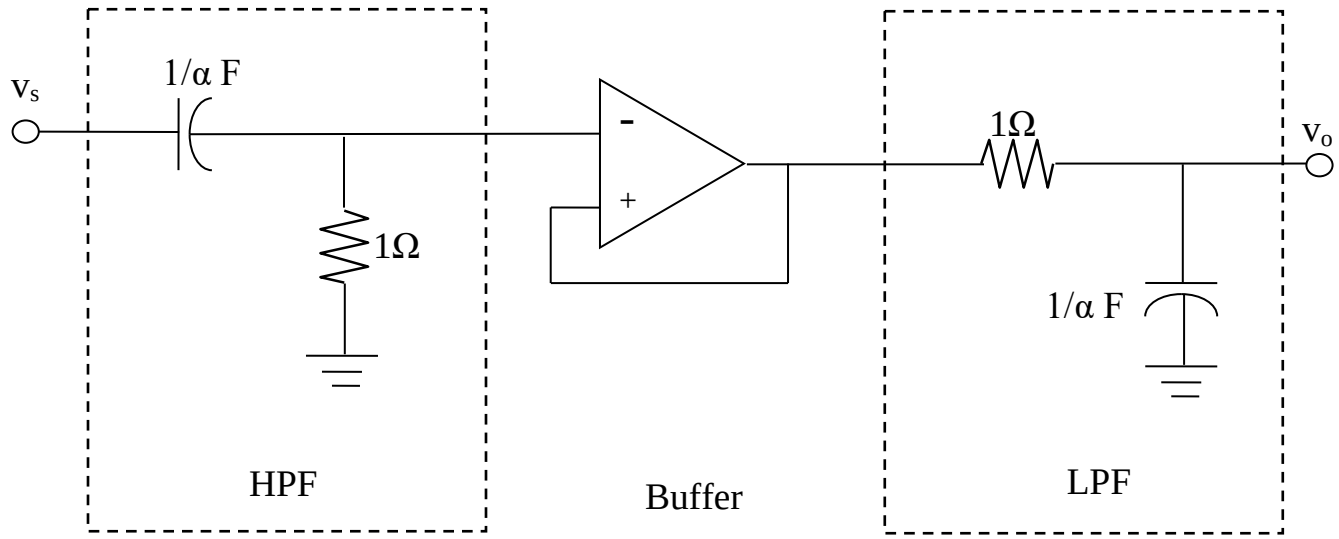
To make this a band pass filter you need to determine which cutoff frequency corresponds to the low pass filter and which the high pass filter. We want to pass frequencies over 1000 r/s so the HPF has the cutoff of 1000. We then want to block frequencies over 10,000 r/s so the LOP has a cutoff of 10,000.

We derived that for both filters, $\alpha = \omega_c$. Determine the K required for the gain to be 1 – set the DC gain to 1 for the LPF and solve for K_1 and then set the infinite frequency gain to 1 on the HPF and solve for K_2.

You should now have 2 circuits to build. Since we will be building these circuits using only op amps, resistors and capacitors we need to modify the transfer function to accommodate this (divide numerator and denominator by s):

$$\text{HPF: } H(s) = 1 \,//\, (1 + 1{,}000/s) \qquad \text{and} \qquad \text{LPF: } H(s) = 10{,}000/s \,//\, (1 + 10{,}000/s)$$

1,000 /s is a capacitor (1/sC) with value C = 1/1,000 F; the 3 constants are resistors with value 1Ω. These circuits can be built with voltage dividers. Remember to use a buffer between the 2 or the second circuit will draw current and not allow you to use voltage division on the first.



You can design circuits with impractical values and scale the circuit elements to practical values. To do this multiply the resistors by a constant and divide the capacitors by the same constant. This will give you the same transfer function with practical values. Scale the 2 circuits to allow you to build these using the parts you have (0.1 µF capacitors and your given resistors).

Build the LPF and HPF. Look at the Bode plots for each acting separately.

Cascade the 2 by connecting the output of one to the input of the other through a buffer. Look at the Bode plot. Determine the cutoff frequencies. How do you account for the error?