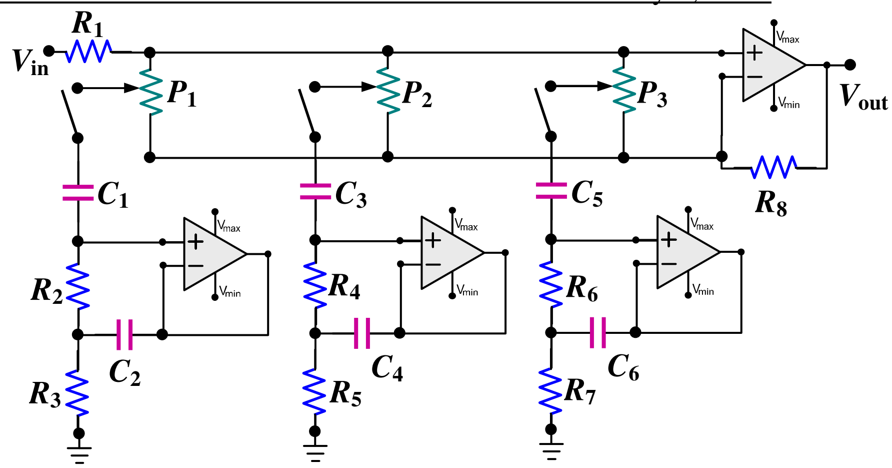
Electrical Circuit Analysis — Dr. Pogo
Virtual Lab: Three Channel Filter — Due May 9, 2024




**I. Model**: Create this circuit in "CircuitMod". $V_{in}$ is a single sinusoidal input with amplitude of 1 volt. If $r = V_{out}/V_{in}$, use the response function $h(\omega) = \left(\frac{r(f)-1}{r(f_0)-1}\right)$.

Again, you will only submit an Excel file, so make sure it has everything you need.

**II. Experiment A**: There are clearly three filters. Use the switches so that only one at a time is connected.
For each filter, measure $V_{out:boost}$ for 20 frequencies. The first frequency is 2 Hz, and each successive frequency is 1.7 times the previous frequency (see table below). Then compute and use $h_{boost}$ to estimate $f_0$, $f_{Lo}$, $f_{Hi}$, and the bandwidth. Three filters, 20 frequencies = 60 measurements.
**Experiment B**: Repeat exp. "A" for $V_{out:cut}$. Another 60 measurements.
**Experiment C**: Now switch on *all three* filters at the same time, and set them *all* to full boost. Measure $V_{out}$ (20 measurements).
**Experiment D**: Repeat for all three filters set to full "cut" (20 measurements).
**Experiment E**: With *all three* filters switched on, set the pots to cut/boost/boost. Measure $V_{out}$. This is a total of 20 measurements.

| | |
|---|---|
| $R_1 = 80\ \text{k}\Omega$ | $P_1 = 80\ \text{k}\Omega$ |
| $R_2 = 20\ \text{k}\Omega$ | $P_2 = 80\ \text{k}\Omega$ |
| $R_3 = 20\ \text{k}\Omega$ | $P_3 = 80\ \text{k}\Omega$ |
| $R_4 = 20\ \text{k}\Omega$ | |
| $R_5 = 20\ \text{k}\Omega$ | $C_1 = 150\ \text{nF}$ |
| $R_6 = 20\ \text{k}\Omega$ | $C_2 = 170\ \text{nF}$ |
| $R_7 = 20\ \text{k}\Omega$ | $C_3 = 33\ \text{nF}$ |
| $R_8 = 100\ \text{k}\Omega$ | $C_4 = 40\ \text{nF}$ |
| | $C_5 = 8.2\ \text{nF}$ |
| $V_{max} = +15\ \text{V}$ | $C_6 = 10\ \text{nF}$ |
| $V_{min} = -15\ \text{V}$ | $T_1 = 5.0\ \text{ms}$ |

**III. Plots**: Make a single log plot of $V_{out}(f)$ with 4 series (exp. "A" and "C").
Make a single log plot of $V_{out}(f)$ with 4 series (exp. "B" and "D").
Make a single **log-log** plot of $V_{out}(f)$ having all 8 of those series.
Make a **log-log** plot of $V_{out}(f)$ with 3 series: (exp. "E", "C", and "D")

**V. Questions:**

| Table of Frequencies for all plots (Hz)… | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | | 17 | | 140 | | 1165 | | 9732 |
| 4 | | 28 | | 237 | | 1981 | | 16545 |
| 6 | | 48 | | 403 | | 3368 | | 28126 |
| 10 | | 82 | | 685 | | 5725 | | 47814 |

1. On the first plot, compare experiment "C" with the other three plots. Estimate the bandwidth of the total experiment "C" plot.
2. What are the advantages and disadvantages of the log-log plot as compared to the log plot?
3. In as few sentences as possible, describe the function of this circuit. If you had to name the three controls (i.e., the potentiometers), what would be possible descriptors of them?
4. Suppose that all switches are connected, and all the potentiometers are set exactly in the middle. Then the output is flat ($V_{out} = V_{in}$) for all frequencies, so none of the filters are boosting or cutting anything. Now, slide the first potentiometer to full boost, without making any other changes. This might be "experiment F" = (boost/mid/mid). How do you think the resulting plot of $V_{out}$ will differ from the first experiment you did (i.e., when you had boost/off/off). Or, in other words, in what ways is *disconnecting* each filter different from just using the potentiometer to "turn it off" by setting it to the middle setting? Even though we didn't do this above, you are permitted to actually do this experiment to help you answer this question if you want.