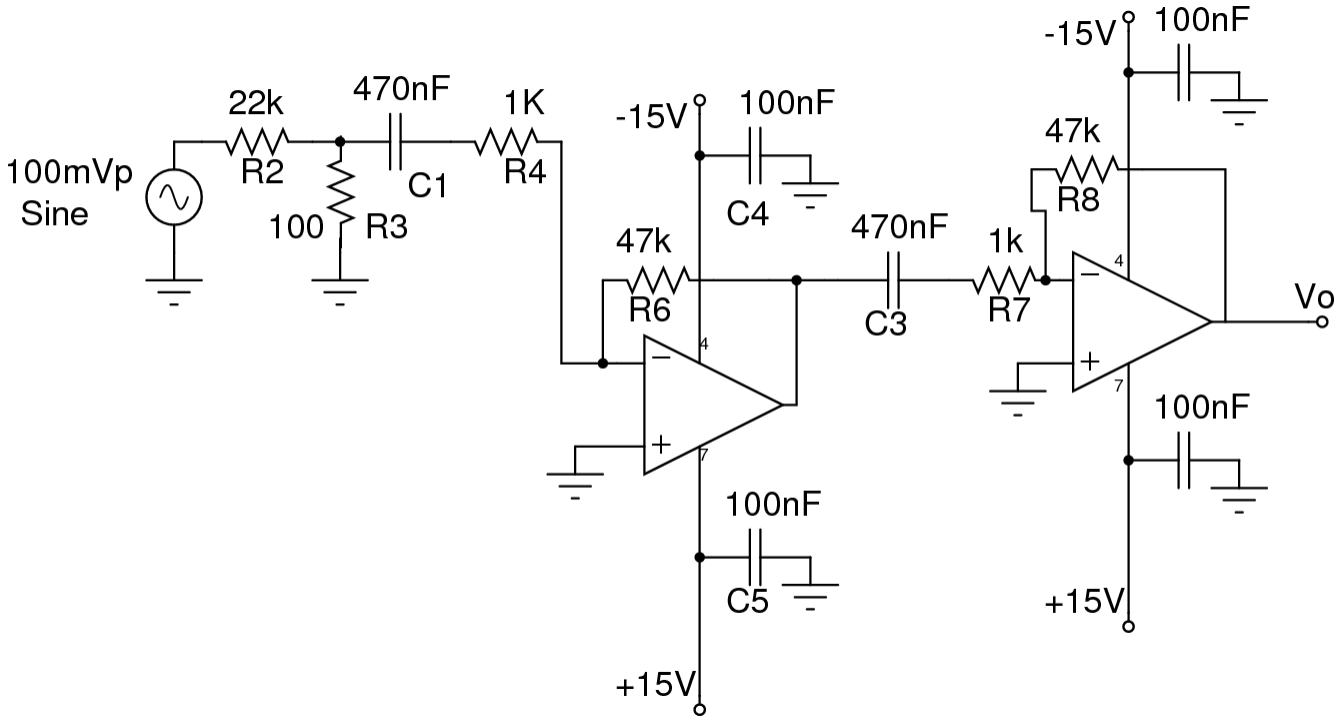
EE 322L

Lab 06: Noise

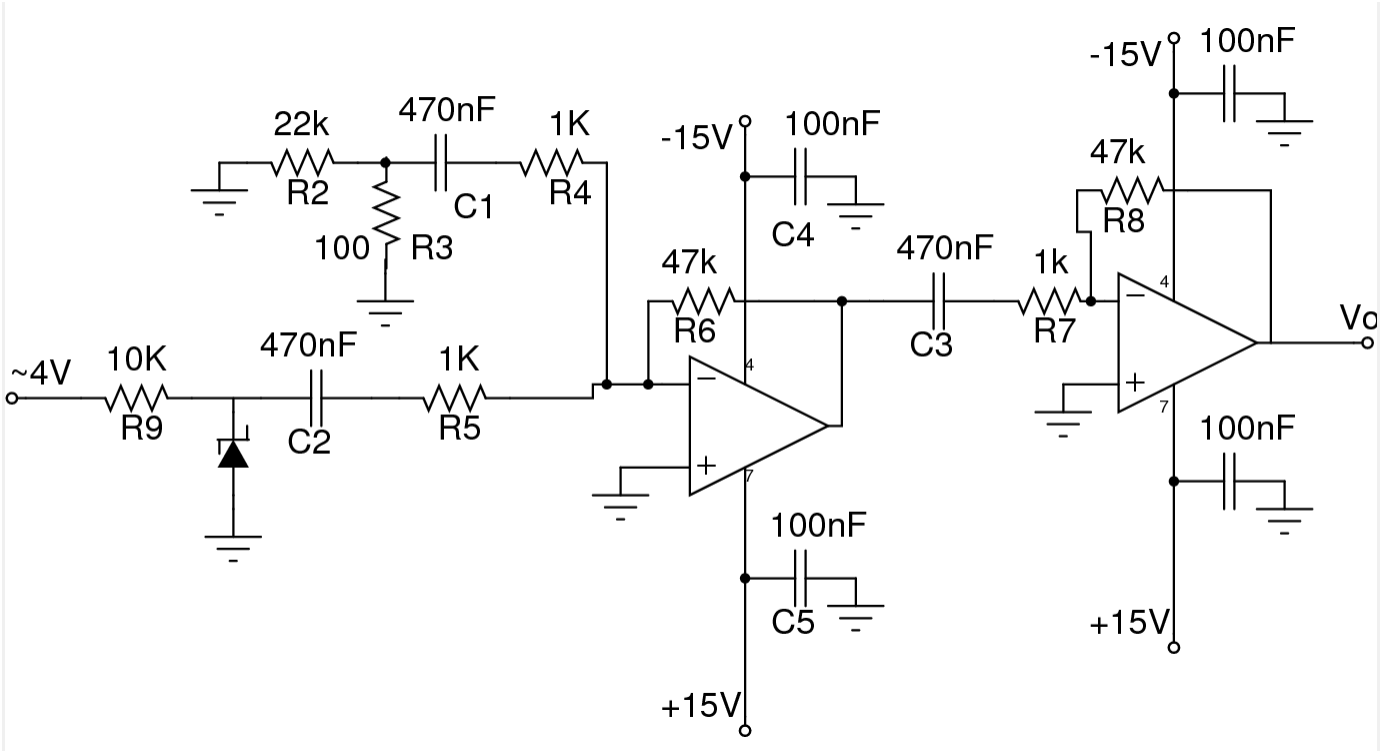
In this lab you will characterize the noise generated by electronics.

Method

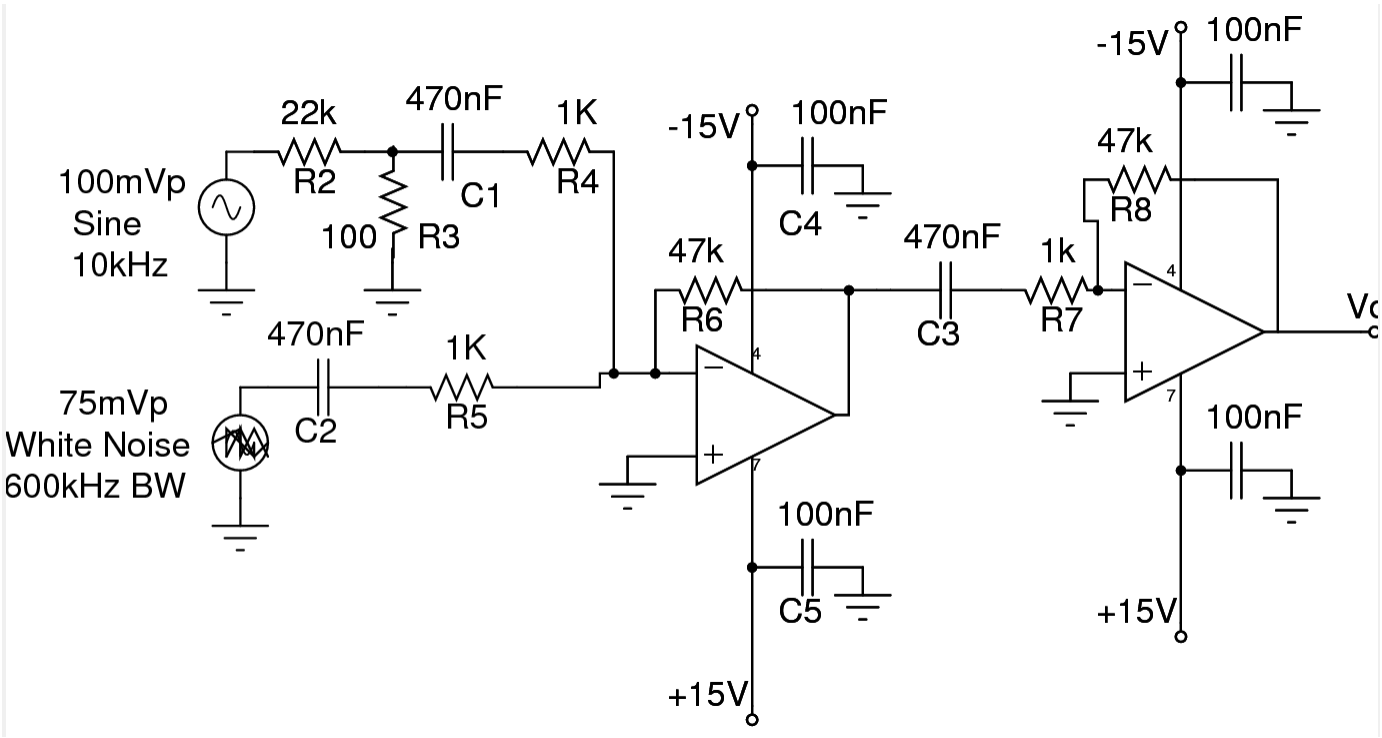
- **1)** Wire up the two-stage amplifier circuit below, using LF411 op-amps. The circuit will amplify a very low amplitude sinusoidal signal into something that can be viewed on an oscilloscope. Explain how you think the circuit works. What is the purpose of R2 and R3? What about the resistors and capacitors feeding into the negative op-amp terminals (e.g. C1 and R4)? What is the benefit of amplifying the signal through two stages?
- **2)** Verify that the output looks as you expect. What is the peak-to-peak signal voltage and RMS signal voltage? Then, vary the frequency of the input sinusoid and describe the effects on the output. What is the gain-bandwidth product of this circuit?



- **3)** The zener diode is a noisy component that can function as a noise source. Tie the "left" end of R2 to ground as shown below. Then, wire up the zener diode circuitry shown (use the 5V-ish zener from your lab kit.) Comment on the new output of the circuit. What is the peak-to-peak noise signal voltage (worst case)? What is the RMS noise voltage?



- **4)** Touch the cathode (the side with the stripe) of the zener with your finger and describe what happens on the output.
- **5)** Estimate the spectral content of the noise output by taking the fast Fourier transform (FFT) with the oscilloscope. Be sure to look for frequencies besides the ambient 60Hz noise that occurs in the room.
- **6)** Reconnect the "left" end of R2 to the signal generator, and comment on the output of circuit. What is the signal-to-noise ratio? Vary the input signal frequency again and describe what happens. What does the gain-bandwidth product of this circuitry appear to be? Has it changed from your previous calculation?
- **7)** Disconnect the zener diode circuitry from the first amplifier stage, and connect instead a 75mVp white noise signal from the function generator with a 600kHz bandwidth. (The circuit is depicted below.) Comment on this output, comparing it with the output generated by the zener noise circuit. What is the SNR now? Using the oscilloscope's FFT function, can you truly characterize the noise as "white"?
- **8)** Design a filter that will maximize the SNR at the output of the second op-amp.


100mVp
Sine
10kHz
22k
R2
470nF
C1
1K
R4
100
R3
75mVp
White Noise
600kHz BW
470nF
C2
1K
R5
-15V
100nF
C4
47k
R6
470nF
C3
1k
R7
47k
R8
-15V
100nF
100nF
C5
+15V
+15V
100nF