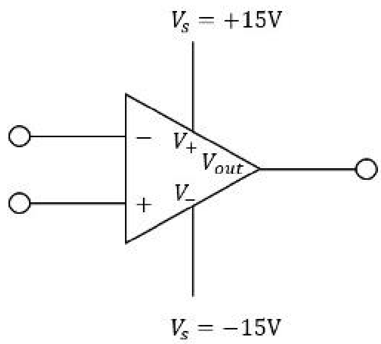
Experiment 7: Op-Amps I

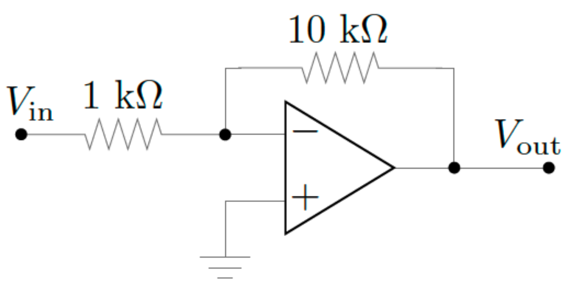
Materials

1. $180\ \Omega,\ 1\ k\Omega,\ 10\ k\Omega,\ 15\ k\Omega,$ $three\ 10\ k\Omega$ resistors
2. $20\ k\Omega$ potentiometer
3. LF411 Op-Amp

Note: For this activity, op-amps need to be biased at both its V_+ and V_- pins. If the activity states that $V_s = \pm15$V, set up the op-amp's V_+ and V_-pins as in figure on the right:

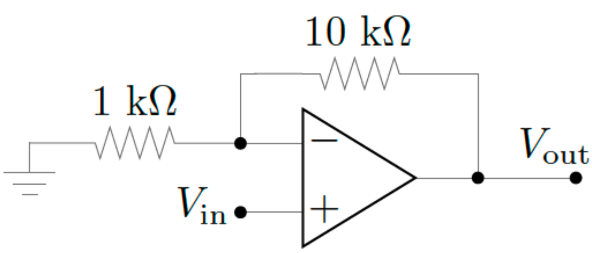


A. Application 1: Inverting Amplifier



1. Construct the following circuit. Use a sine wave input (V_{pp} = 2 V, f = 1 kHz, no offset) and op-amp $V_s = \pm15$ V.
2. Generate the input and output waveforms. Indicate the important voltage values and points on the plot.
3. Determine the experimental value of the voltage gain (V_{out}/V_{in}) and compare it with the theoretical value $G = -R_1/R_2$
4. Is the output inverted or not with respect to the input?
5. Name the circuit and explain the output waveform. What are the circuit's possible applications?
6. Increase the amplitude of the input until clipping of the output starts to occur. Take note of the voltage value where the output is clipped. Explain why the clipping occurs at this value.

B. Application 2: Non-inverting Amplifier



1. Construct the following circuit. Use a sine wave input (V_{pp} = 2 V, f = 1 kHz, no offset) and op-amp $V_s = \pm15$ V.
2. Generate the input and output waveforms. Indicate the important voltage values and points on the plot.
3. Determine the experimental value of the voltage gain (V_{out}/V_{in}) and compare it with the theoretical value $G = (R_1+R_2)/R_2$
4. Is the output inverted or not with respect to the input?
5. Name the circuit and explain the output waveform. What are the circuit's possible applications?

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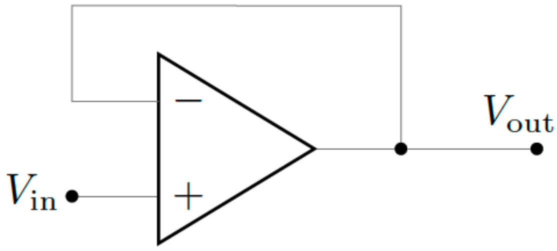
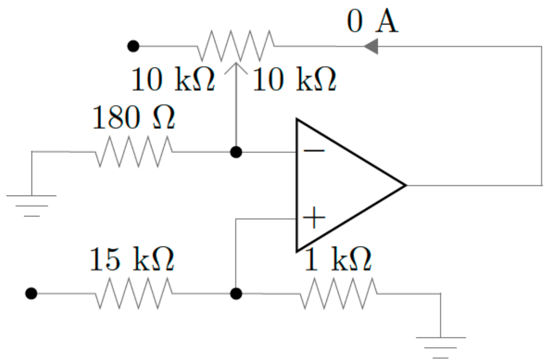
C. Application 3: Voltage Follower



1. Construct the following circuit. Use a sine wave input (V_{pp} = 2 V, f = 1 kHz, no offset) and op-amp V_s = ±15 V.
2. Generate the input and output waveforms. Indicate the important voltage values and points on the plot.
3. Determine the experimental value of the voltage gain (V_{out}/V_{in}) and compare it with the theoretical value $G=1$.
4. Is the output inverted or not with respect to the input?
5. Name the circuit and explain the output waveform. What is the importance of this circuit?

D. Application 4: Differential Amplifier/Subtractor



1. Construct the following circuit. Use op-amp V_s = ± 15 V.
2. Vary the R_{load} from 1 kΩ to 20 kΩ (suggested increment:2 kΩ) and measure the current passing through the R_{load}.
3. Plot I_{load} vs. R_{load}. What happens to the current as the R_{load} is increased?
4. Compare the performance of this circuit to that of the transistor current source (E5)

E. Application 5: Inverting Summing Amplifier/Subtractor

1. Construct the following circuit. Use a sine wave input (V_{pp} = 2 V, f = 1 kHz, no offset) and op-amp V_s = ±15 V.
2. Generate the inputs (V_{DC} and V_{in}) and output waveforms. Indicate the important voltage values on the plot.
3. Repeat steps 1 and 2 for V_{DC} = −5 V and V_{DC} = 0 V.
4. Explain the circuit's primary function and its applications.