Lab 4 Review

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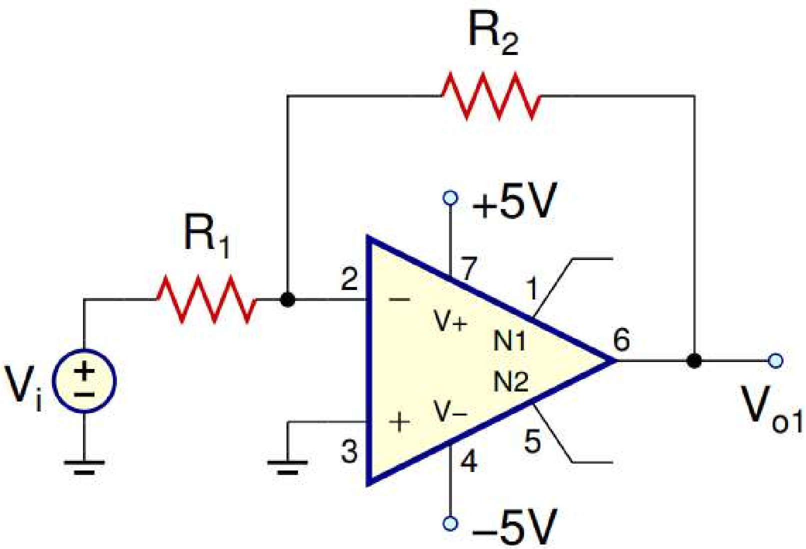
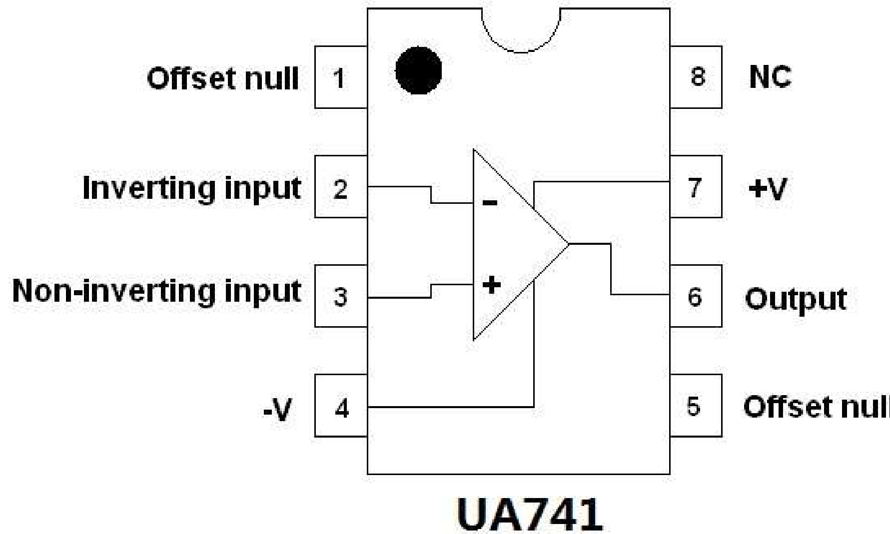
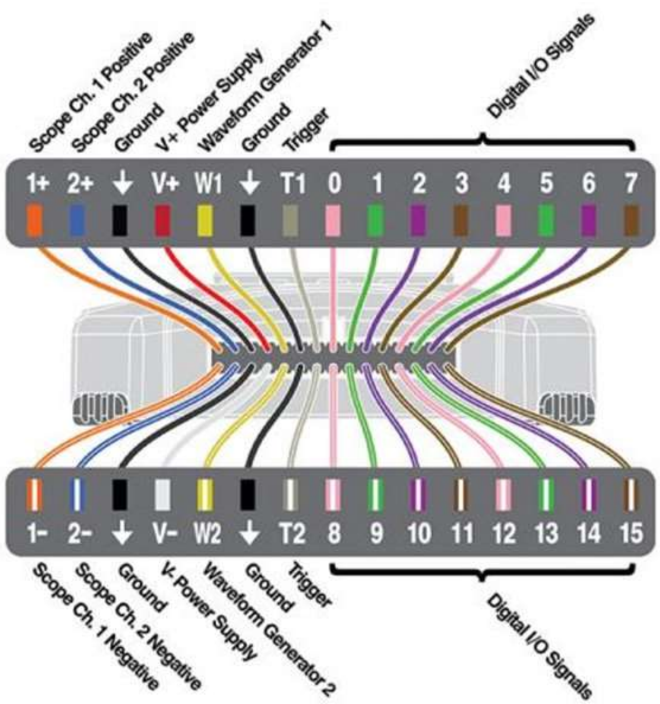
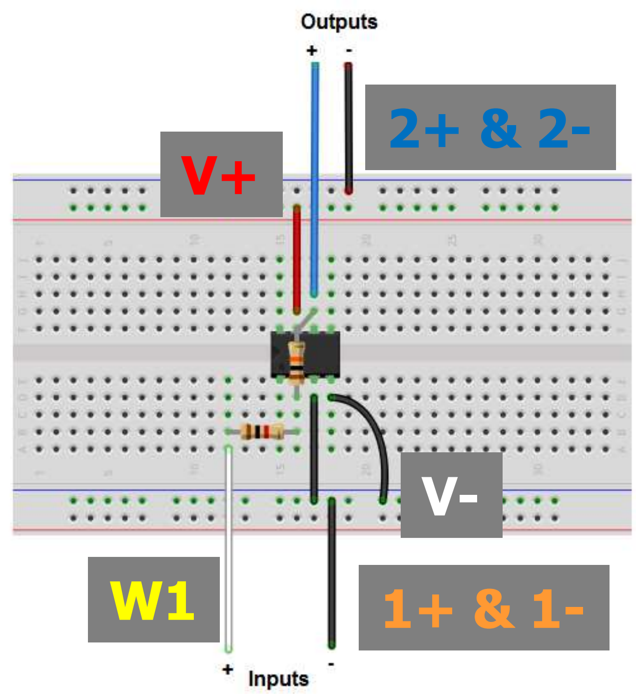
Connecting the IC

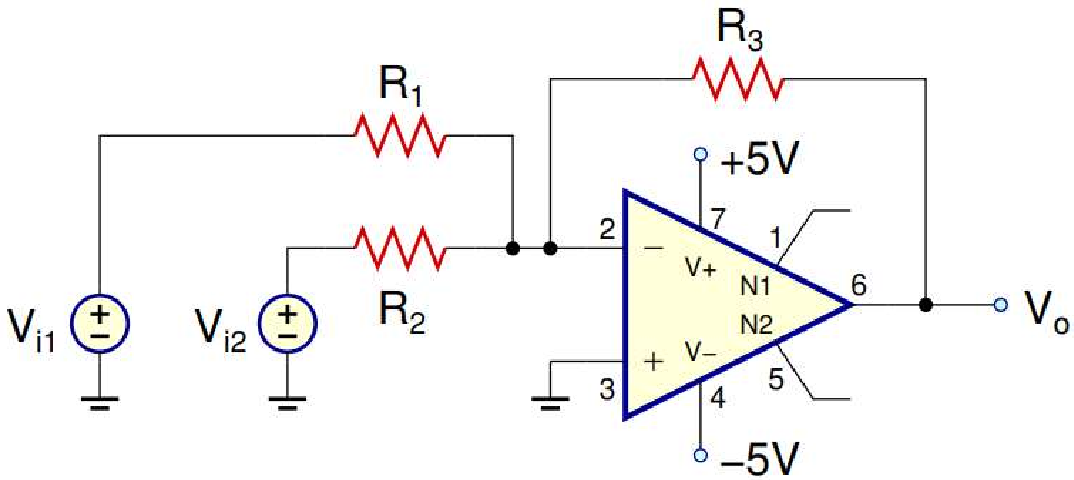




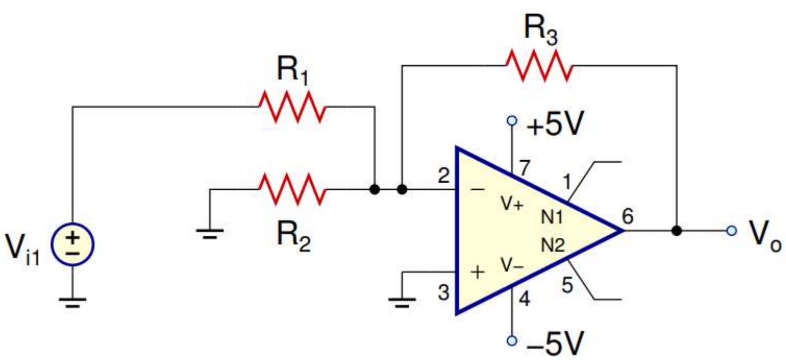


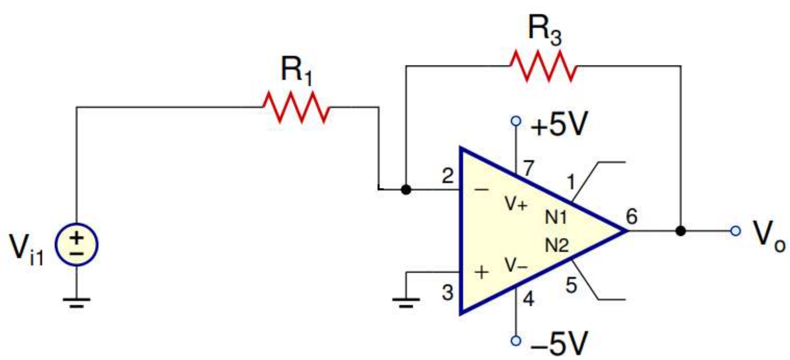


Summing Amplifier Circuit



Using superposition…

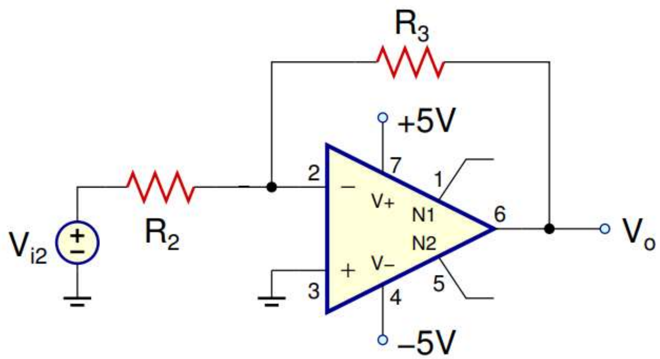




$$V_o = -\frac{R_3}{R_1} V_{i1}$$

Summing Amplifier Circuit

Similarly…



$$V_o = -\frac{R_3}{R_2} V_{i2}$$

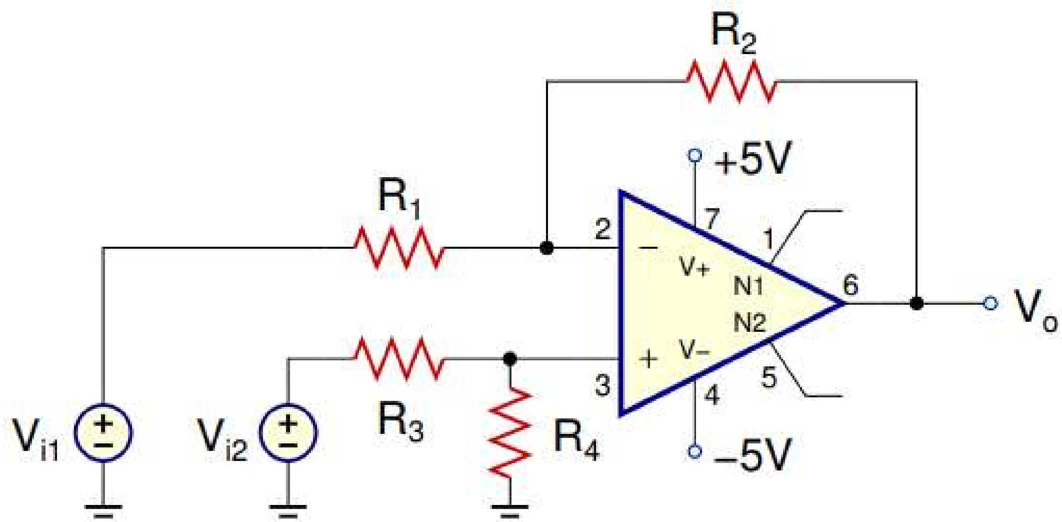
Now, due to the superposition theorem we can add the two inputs independently

$$V_o = -\frac{R_3}{R_1} V_{i1} + \left(-\frac{R_3}{R_2} V_{i2}\right) = -\left(\frac{R_3}{R_1} V_{i1} + \frac{R_3}{R_2} V_{12}\right)$$

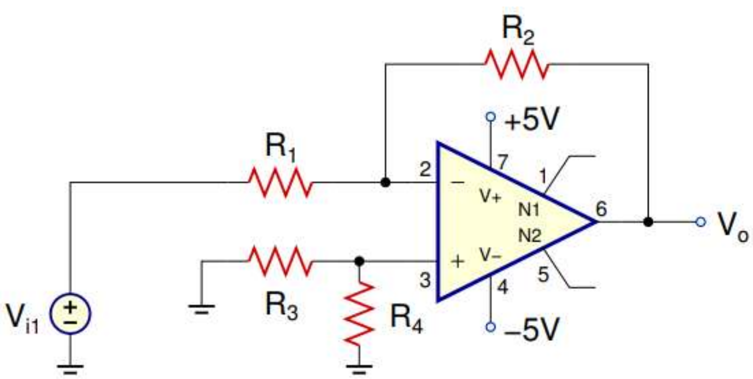
For the summing amplifier in Fig. 1, find R1 and R2 to have Vo = −(Vi1 + 2Vi2), if R3 = 15kΩ

R1 = 15 kΩ
R2 = 7.5 kΩ

Differential Amplifier Circuit



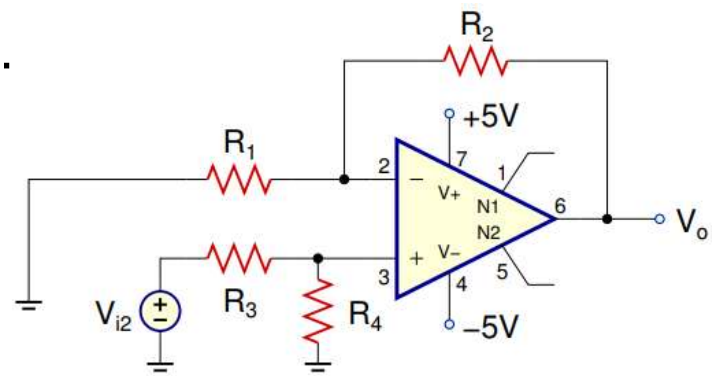
Using superposition…



$$V_o = -\frac{R_2}{R_1} V_{i1}$$

Differential Amplifier Circuit

Similarly…



$$V_o = \frac{R_4}{R_3 + R_4}\left(1 + \frac{R_2}{R_1}\right)V_{i2}$$

Now, due to the superposition theorem we can add the two inputs independently

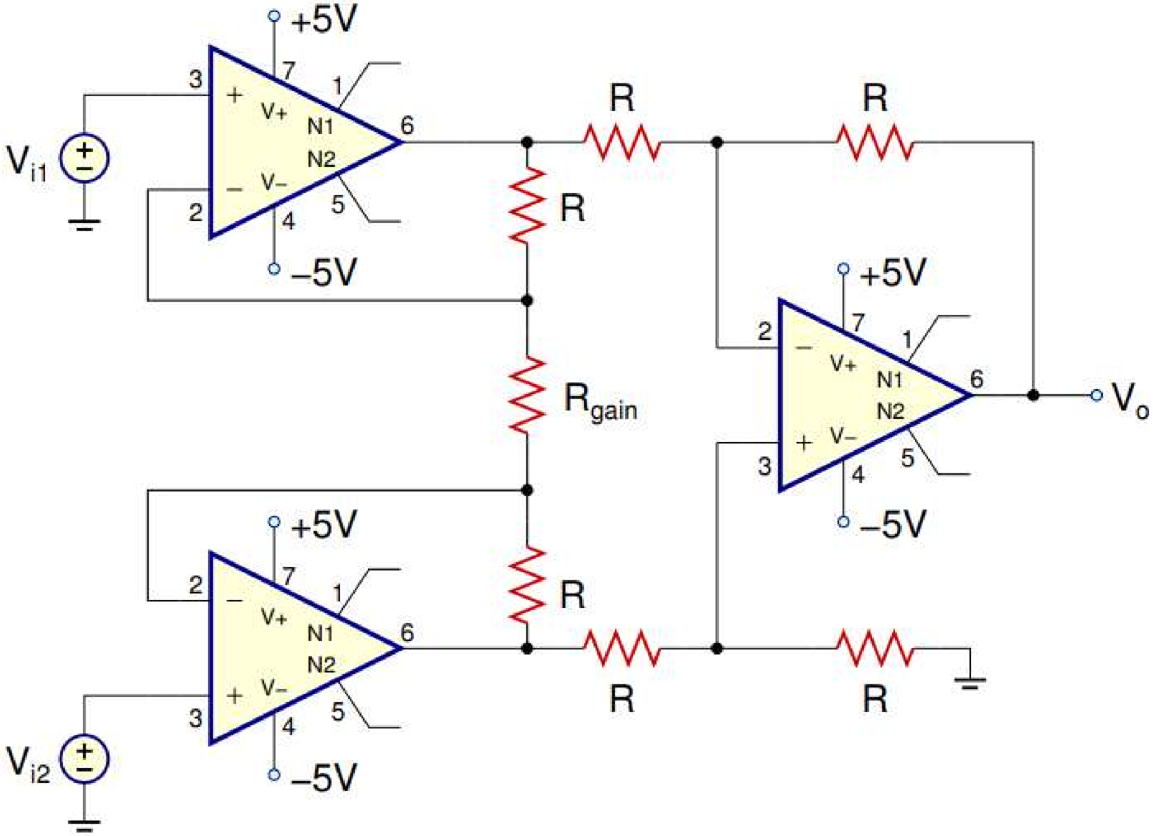
$$V_o = -\frac{R_2}{R_1}V_{i1} + \frac{R_4}{R_3 + R_4}\left(1 + \frac{R_2}{R_1}\right)V_{i2} \quad \text{or} \quad V_o = -\frac{R_2}{R_1}V_{i1} + \frac{\frac{R_4}{R_3}}{1 + \frac{R_4}{R_3}}\left(1 + \frac{R_2}{R_1}\right)V_{i2}$$

If R2/R1 = R4/R3… $V_o = -\frac{R_2}{R_1}V_{i1} + \frac{\frac{R_2}{R_1}}{1 + \frac{R_2}{R_1}}\left(1 + \frac{R_2}{R_1}\right)V_{i2}$ ➡ $V_o = \frac{R_2}{R_1}(V_{i2} - V_{i1})$

For the differential amplifier in Fig. 2, find R1 to have Vo = Vi2 − Vi1, if R2 = R3 = R4 = 10kΩ.

➡ R1 = 10 kΩ

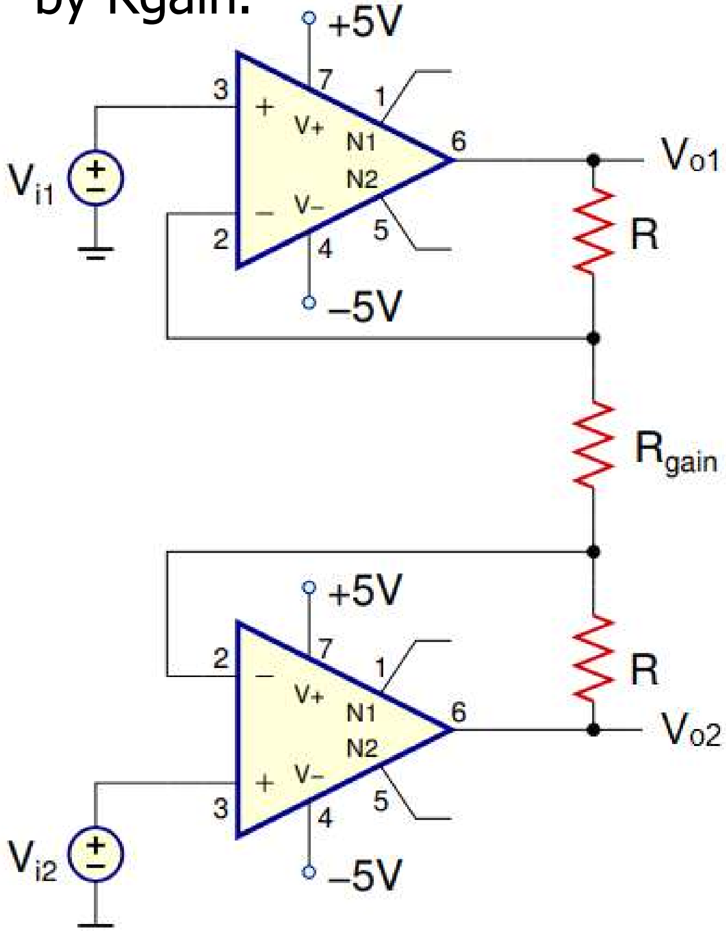
Instrumentation Amplifier



- The instrumentation amplifier offers the following advantages:
  - Very high input impedance
  - High common-mode rejection ratio
  - Low offset
  - Low noise

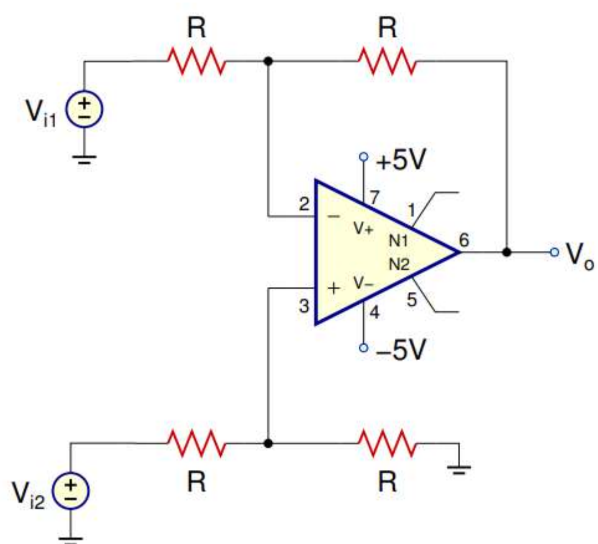
Instrumentation Amplifier

The input stages operate as non-inverting amplifiers where the gain is defined by Rgain.



$$V_{o1,2} = \left(1 + \frac{R}{\frac{R_{gain}}{2}}\right) V_{i1,2}$$

$$V_{o2} - V_{o1} = \left(1 + \frac{2R}{R_{gain}}\right) (V_{i2} - V_{i1})$$



Vo = Vi2 − Vi1

The third op-amp is working as the differential amplifier that we just analyzed.