Physics 231

Lecture 4: Op Amps II

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The Op-Amp Golden Rules:

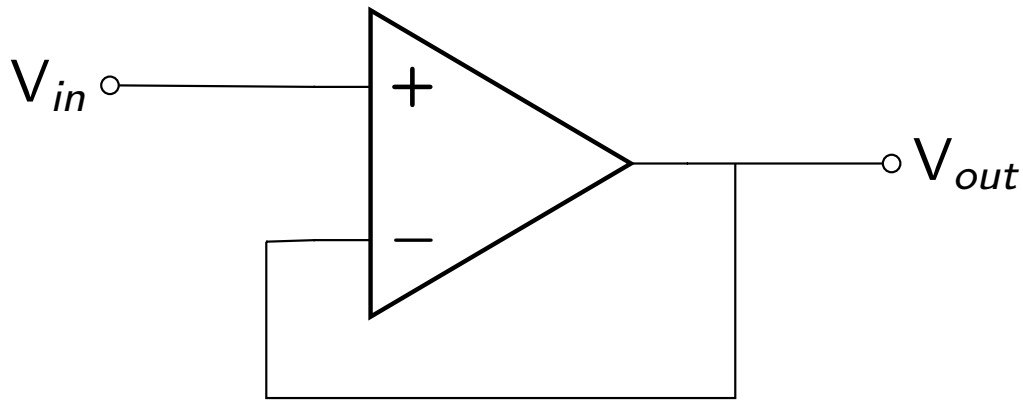
The input leads draw no current
High input resistance

The output can produce enough current to drive any load
Low output resistance

The output output tries to make the input voltages the same
Operational amplifiers are usually used with feedback

Basic Op-Amp Circuits: Follower/Buffer

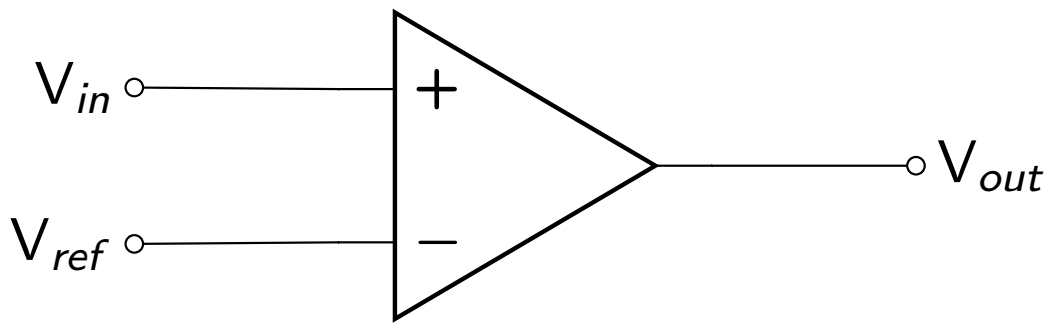
$$V_{out} = V_{in}$$



Task: Make a follower that buffers negative voltages as well using an LM 741 op-amp.

Basic Op-Amp Circuits: Comparator

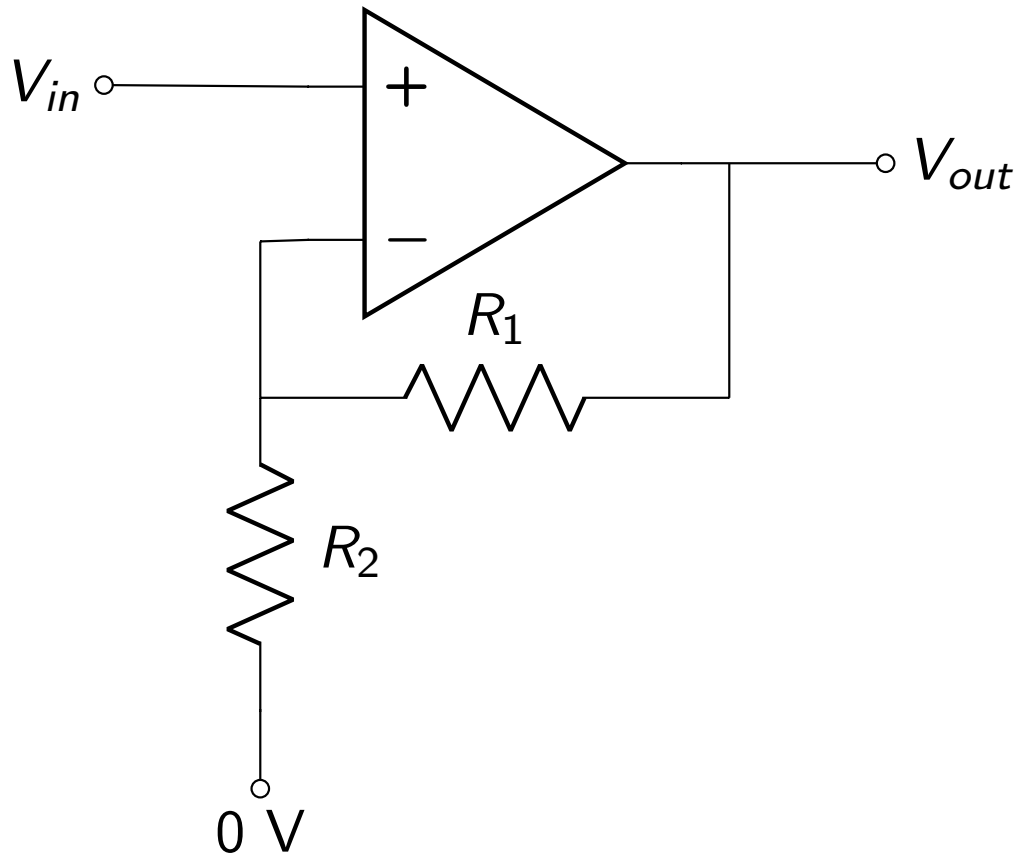
$$V_{out} \rightarrow \begin{cases} HIGH, & \text{if } V_{in} > V_{ref}. \\ LOW, & \text{if } V_{in} < V_{ref}. \end{cases}$$



Task: Make an comparator that outputs HIGH when $V_{in} > V_{ref}$.
Set V_{in} using a potentiometer.

Basic Op-Amp Circuits: Amplifier (non-inverting)

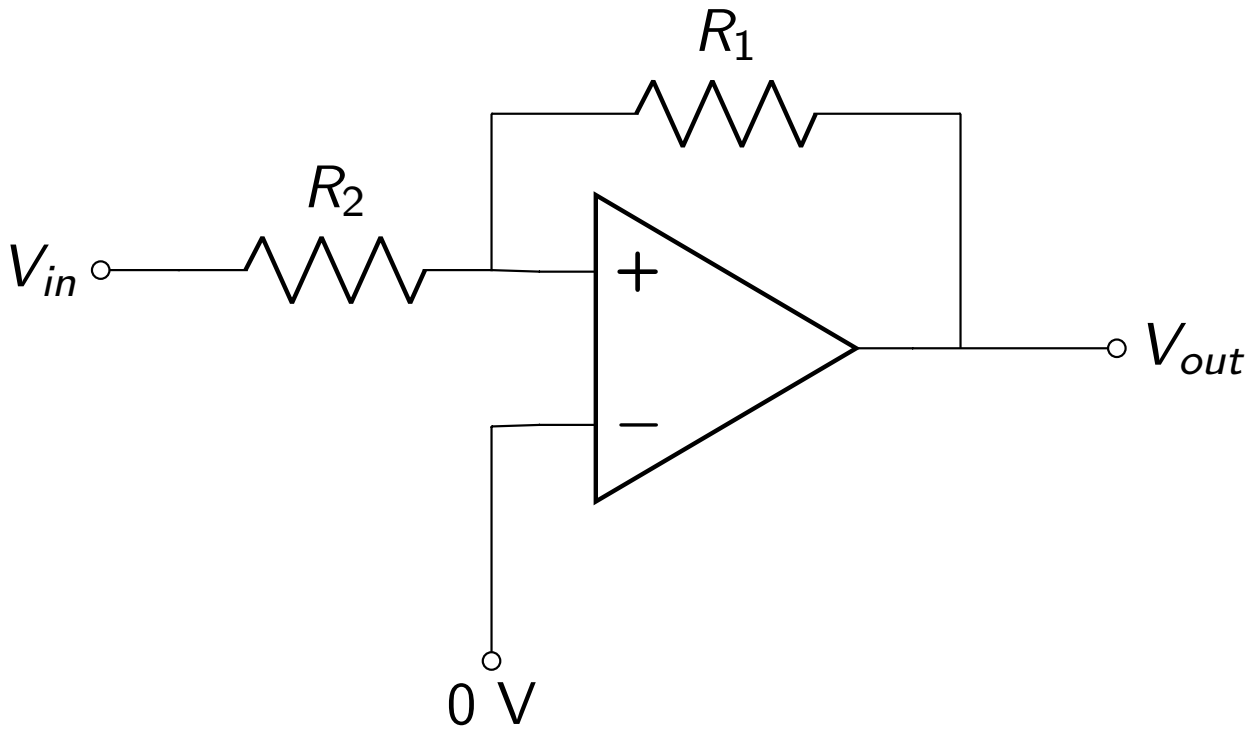
$$V_{out} = \left(1 + \frac{R_1}{R_2}\right) V_{in}$$



Task: Derive the gain equation for this amplifier.

Hint: Adapt the voltage divider equation.

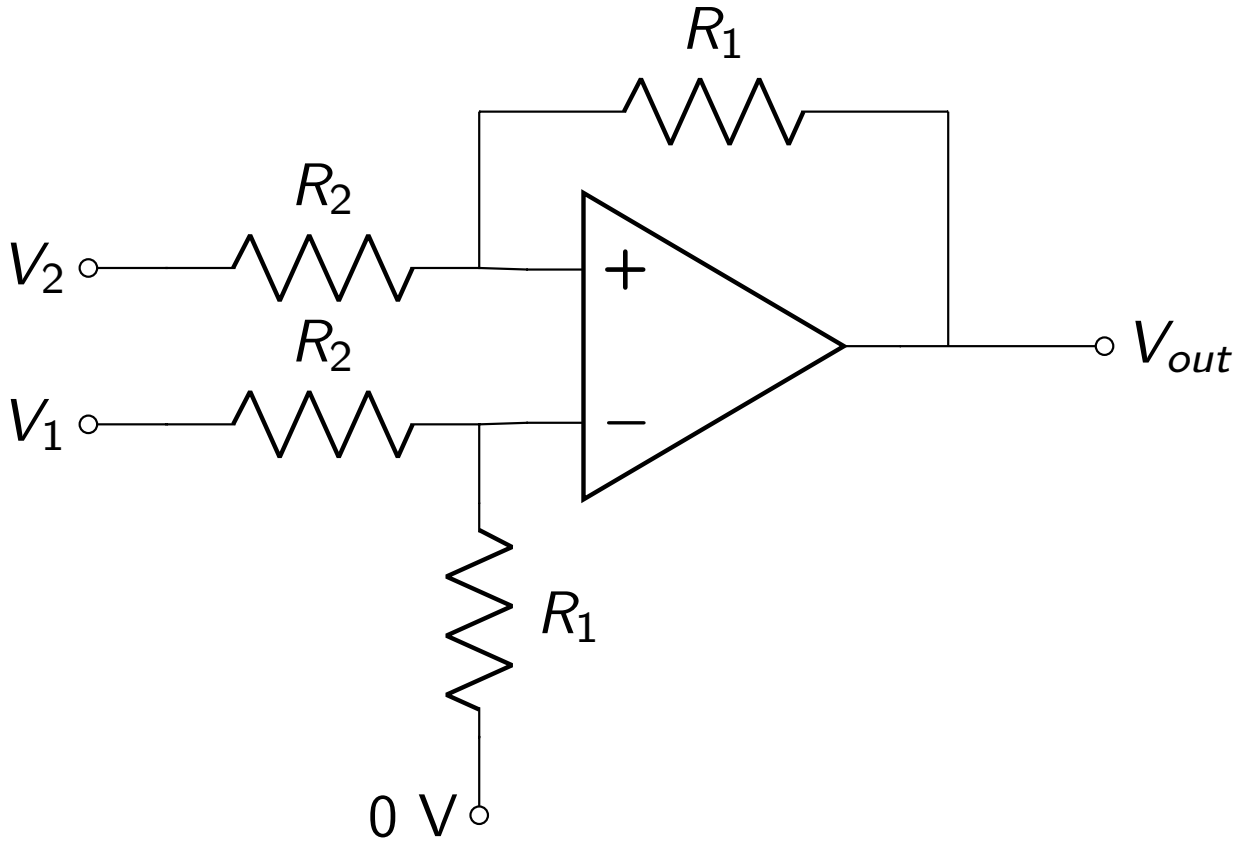
Basic Op-Amp Circuits: Amplifier (inverting)



Task: Derive the gain equation for this amplifier. Build and test it. What might this be used for? What is a disadvantage?

Basic Op-Amp Circuits: Differential Amplifier

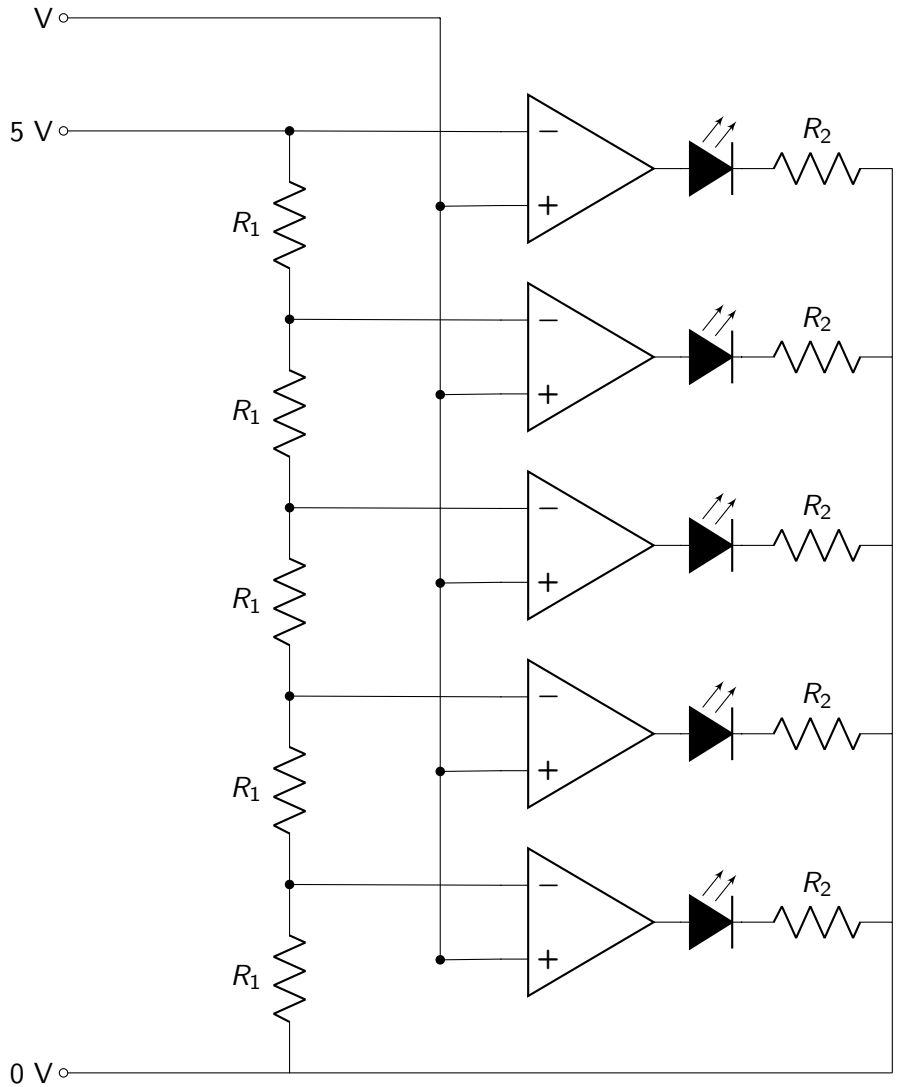
$$V_{out} = \frac{R_1}{R_2}(V_2 - V_1)$$



Task: Build and test.

Adapt to amplify small changes around a reference of 2.5 V.

2 bit Analog-to-Digital Converter (ADC):



How would you choose appropriate R_1 and R_2?