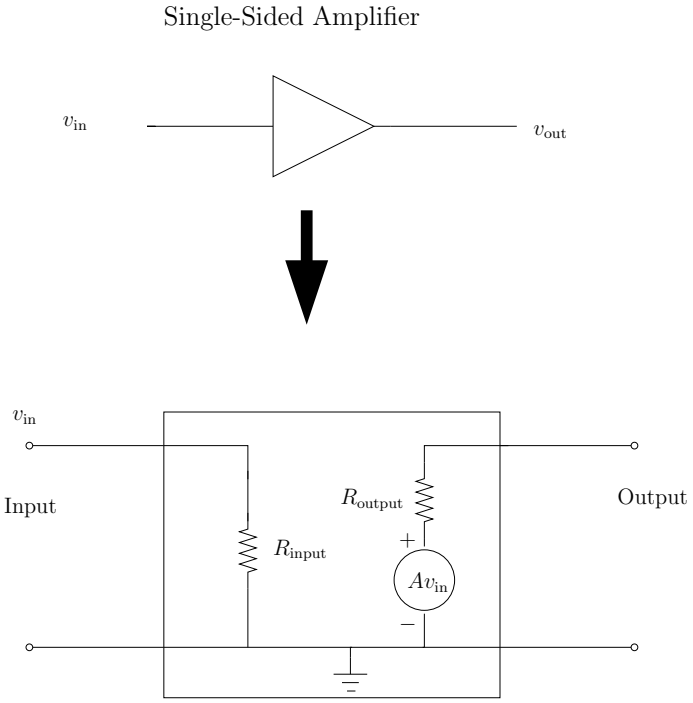
Topic 9

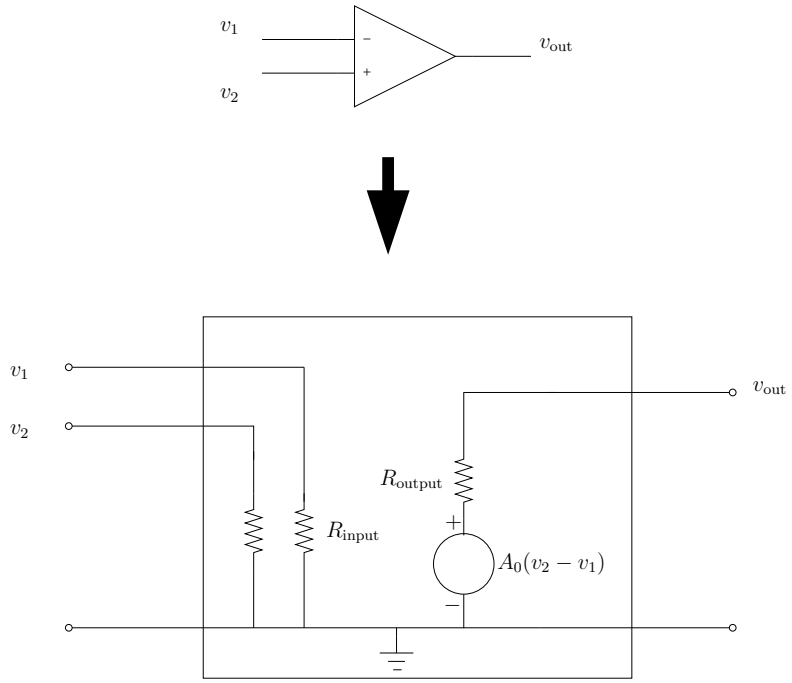
Amplifiers and Operational Amplifiers (Op-Amps)

9.1 General Amplifier Theory

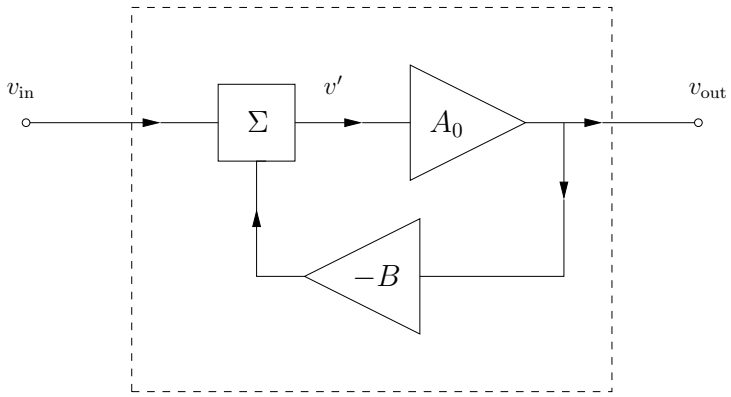
9.1.1 Input Impedance, Output Impedance, & Gain



Differential Amplifier (Ground Implied)



9.1.2 Abstract Model of Negative Feedback



$$v_{\text{out}} = A_0 v' = A_0(v_{\text{in}} - B v_{\text{out}})$$

9.2 Ideal Op-Amps With Negative Feedback

For ideal op-amps with negative feedback:

1. The inputs draw no current.
2. The output attempts to do whatever is necessary to make the voltage difference between the two inputs zero.

Examples discussed in class, lab, and homework. (You should be able to derive outputs of these and similar amplifiers using ideal op-amp rules.)

- Inverting amplifier
- Non-inverting amplifier
- Voltage follower
- Summing amplifier
- Current source

9.3 Ideal Op-Amps with Positive Feedback (or no feedback)

- Comparators and level-crossing detectors.
- Schmitt trigger.

9.4 Ideal Op-Amp with Capacitave Feedback

- Square-wave generator.

9.5 Non-Ideal Op-Amps

- Non-zero bias current. $I_B \neq 0$, ($I_{B+} \neq I_{B-}$)
- Output doesn't respond instantly to changes in input; finite *slew rate*.
- Non-zero offset voltage; $v_{\text{out}} \neq 0$ when $v_2 = v_1$.
- Voltage gain not infinite; voltage gain not independent of frequency.

- Input impedance not infinite.
- Upper limit to current an op-amp can source or sink.