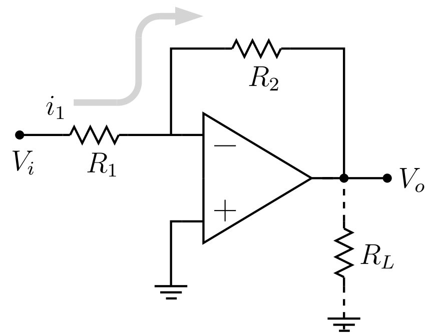
ee101_inv_amp_1.sqproj



Shown in the figure is an Op Amp based inverting amplifier. In this circuit, the Op Amp operates in the linear regime, which guarantees that the inverting and non-inverting terminals of the Op Amp are approximately at the same potential, i.e.,

$$V_+ - V_- \approx 0\,V\,. \tag{1}$$

Since $V_+ = 0\,V$, V_- is also at $0\,V$. Further, owing to a large input resistance of the Op Amp, the current entering (or leaving) the Op Amp through the inverting terminal is negligible, and we get

$$\frac{V_i - V_-}{R_1} = \frac{V_- - V_o}{R_2} \Rightarrow V_o = -\frac{R_2}{R_1}\,V_i\,, \tag{2}$$

Eq. 2 implies that the desired gain can be achieved by simply choosing appropriate values of R_1 and R_2, and it frees the user from biasing considerations which arise in a common-emitter amplifier, for example. Further, the inverting amplifier can be used to amplify a DC voltage as well, which is not possible to do with a common-emitter amplifier where the coupling capacitors would block DC voltages.

Note that the output voltage is limited by $\pm V_{\text{sat}}$, the saturation levels of the Op Amp (about $(V_{CC} + 1\,V)$ and $(-V_{EE} - 1\,V)$).

Exercise Set

1. For a sinusoidal input voltage with amplitude $50\,\text{m}V$ and frequency $1\,\text{kHz}$, what is the expected output voltage if $R_1 = 1\,\text{k}\Omega$ and $R_2 = 10\,\text{k}\Omega$? By simulation, obtain a plot of V_i and V_o versus t for a few cycles, and verify your answer. Observe the phase relationship between the input and output voltages.

2. For a supply voltage of $\pm 15\,V$, what is the maximum amplitude of the input voltage for which the output is distortion-free? Verify with simulation.
3. For a $0.5\,V$ peak-to-peak triangular input with $f = 1\,\text{kHz}$, and a DC offset of $0.2\,V$, sketch $V_o(t)$ with $R_1 = 1\,\text{k}\Omega$, $R_2 = 10\,\text{k}\Omega$. Verify with simulation.