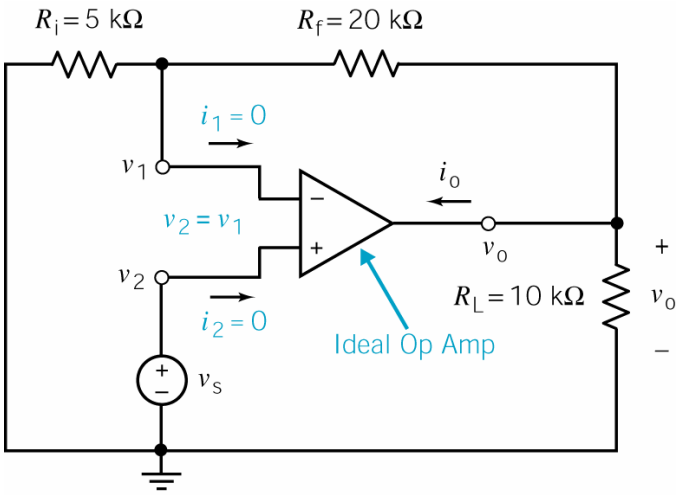
The Noninverting Amplifier



The voltage source causes $v_2 = v_s$. The op amp is ideal so $v_1 = v_2$. (All op amps are ideal in this course.) Consequently,

$$v_1 = v_2 = v_s$$

Apply KCL at the node connected to the inverting input of the op amp to get

$$\frac{0 - v_1}{R_i} = i_1 + \frac{v_1 - v_o}{R_f} \quad \Rightarrow \quad \frac{-v_s}{R_i} = \frac{v_s - v_o}{R_f} \quad \Rightarrow \quad v_o = \left(1 + \frac{R_f}{R_i}\right) v_s = 5 v_s$$

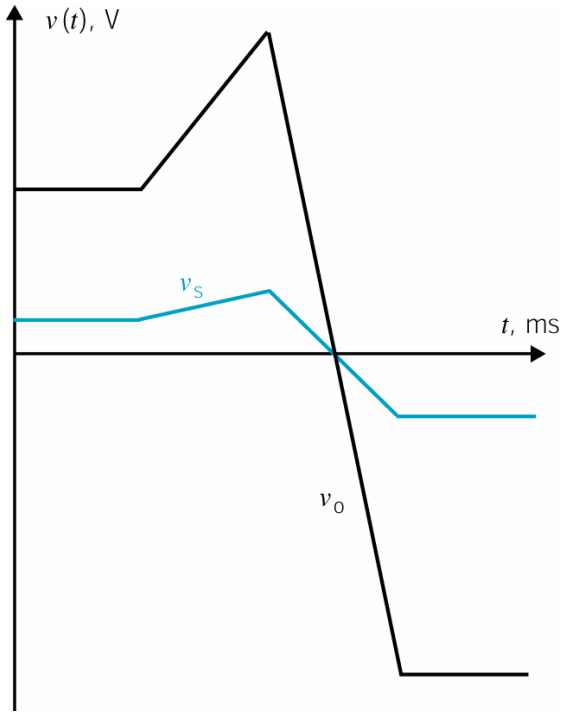
Apply KCL at the output node of the op amp to get

$$\frac{v_1 - v_o}{R_f} = i_o + \frac{v_o}{R_L} \quad \Rightarrow \quad i_o = -\left(\frac{1}{R_f} + \frac{1}{R_L}\right) v_o + \frac{1}{R_f} v_s = -\left(\frac{1}{R_f} + \frac{1}{R_L}\right)\left(1 + \frac{R_f}{R_i}\right) v_s + \frac{1}{R_f} v_s$$

$$= -\left(\frac{1}{R_i} + \frac{1}{R_L}\left(1 + \frac{R_f}{R_i}\right)\right) v_s$$

$$= \left(0.45 \times 10^{-3}\right) v_s$$

The input to this circuit is the voltage source voltage, v_s. The output is the voltage, v_o, across R_L. Consider this plot of the input and output voltages for a particular input:



The output is seen to be 5 times as large as the input. The output is not inverted with respect to the input. Appropriately, the circuit is called an noninverting amplifier.