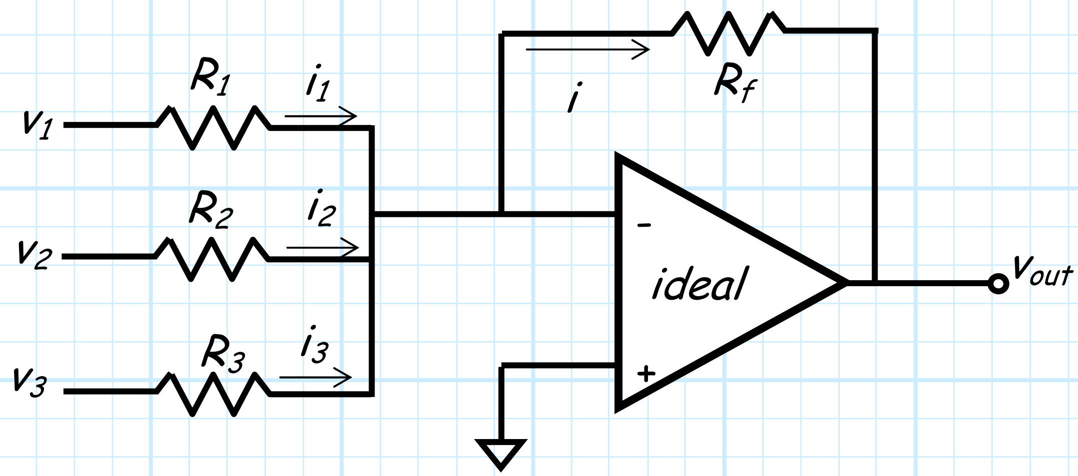
The Weighted Summer

Consider an inverting amplifier with **multiple** inputs!



From **KCL**, we can conclude that the currents are related as:

$$i = i_1 + i_2 + i_3$$

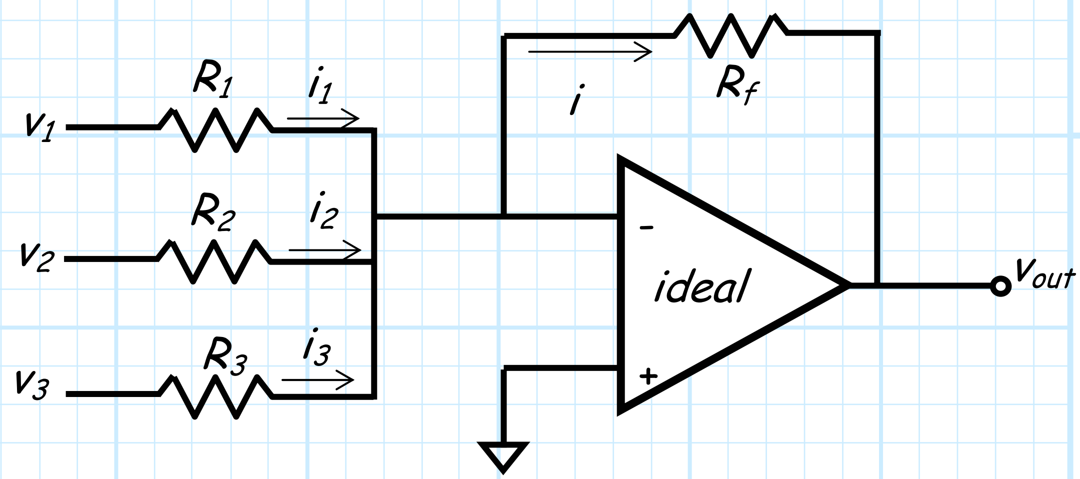
and because of **virtual ground** ($i_- = i_+ = 0$), we can conclude from **Ohm's Law**:

$$i_1 = \frac{v_1 - v_-}{R_1} = \frac{v_1}{R_1} \qquad i_2 = \frac{v_2 - v_-}{R_2} = \frac{v_2}{R_2} \qquad i_3 = \frac{v_3 - v_-}{R_3} = \frac{v_3}{R_3}$$

The output voltage

Likewise:

$$i = \frac{v_- - v_{out}}{R_f} = \frac{-v_{out}}{R_f}$$



Inserting these results into the initial KCL expression:

$$\frac{-v_{out}}{R_f} = \frac{v_1}{R_1} + \frac{v_2}{R_2} + \frac{v_3}{R_3}$$

Now, we sprinkle on some algebraic pixie dust, and find the output voltage:

$$v_{out} = -\frac{R_f}{R_1} v_1 - \frac{R_f}{R_2} v_2 - \frac{R_f}{R_3} v_3$$

The output is thus a weighted summation of each of the input signals!

We therefore refer to this circuit as the **weighted summer**.

How to combine signals

Note that if $R_f = R_1 = R_2 = R_3$, the output is an **unweighted summer**:

$$v_{out}(t) = -\left(v_1(t) + v_2(t) + v_3(t)\right)$$

For example, if:

$$v_1(t) = 2.0\cos\left(2\pi t + \pi\right)$$

$$v_2(t) = 1.0\cos\left(2\pi t + \pi/3\right)$$

$$v_3(t) = 1.5\cos\left(2\pi t - \pi/4\right)$$

then:

$$v_{out}(t) = -2.0\cos(2\pi t + \pi) - 1.0\cos(2\pi t + \pi/3) - 1.5\cos(2\pi t - \pi/4)$$

The summer is a method for **combining** several signals!