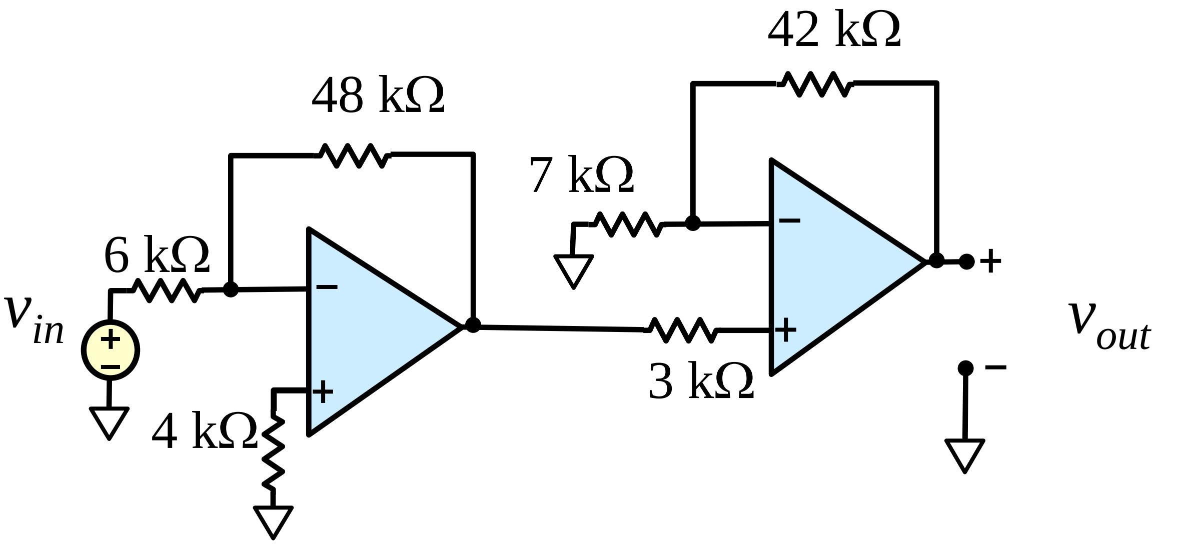
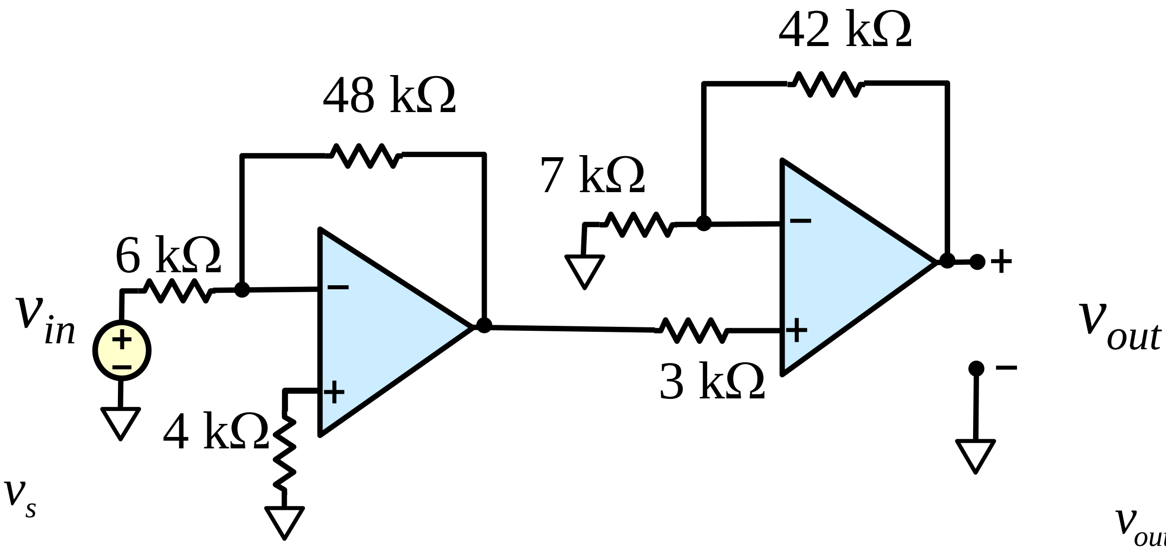
Example 1



Find the gain $\frac{v_{out}}{v_{in}}$

Find v_{out} if v_{in} = 20 mV

Example 1 Solution



$$v_{out} = -\frac{R_f}{R_s} v_s$$

$$v_{out} = \left[1 + \frac{R_f}{R_s}\right] v_s$$

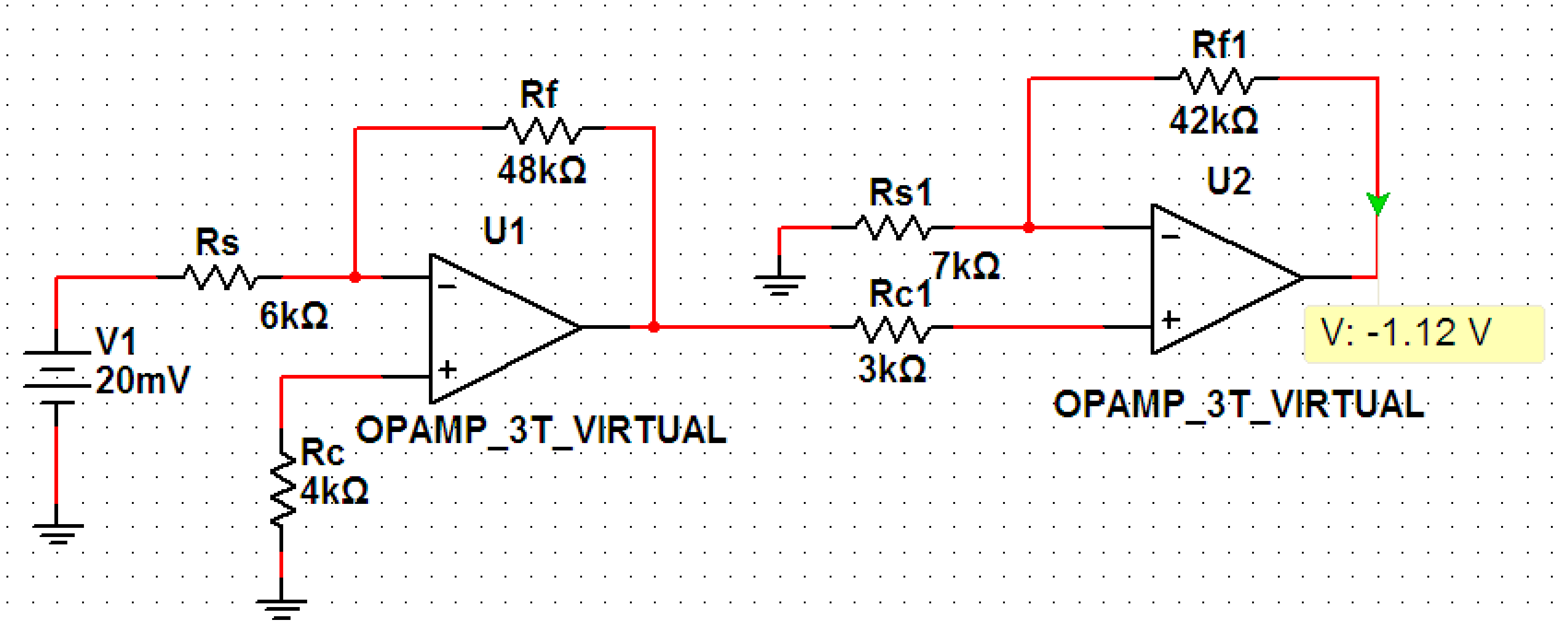
$$A_1 = -\frac{R_f}{R_s} = -8$$

$$A_2 = 1 + \frac{R_f}{R_s} = 7$$

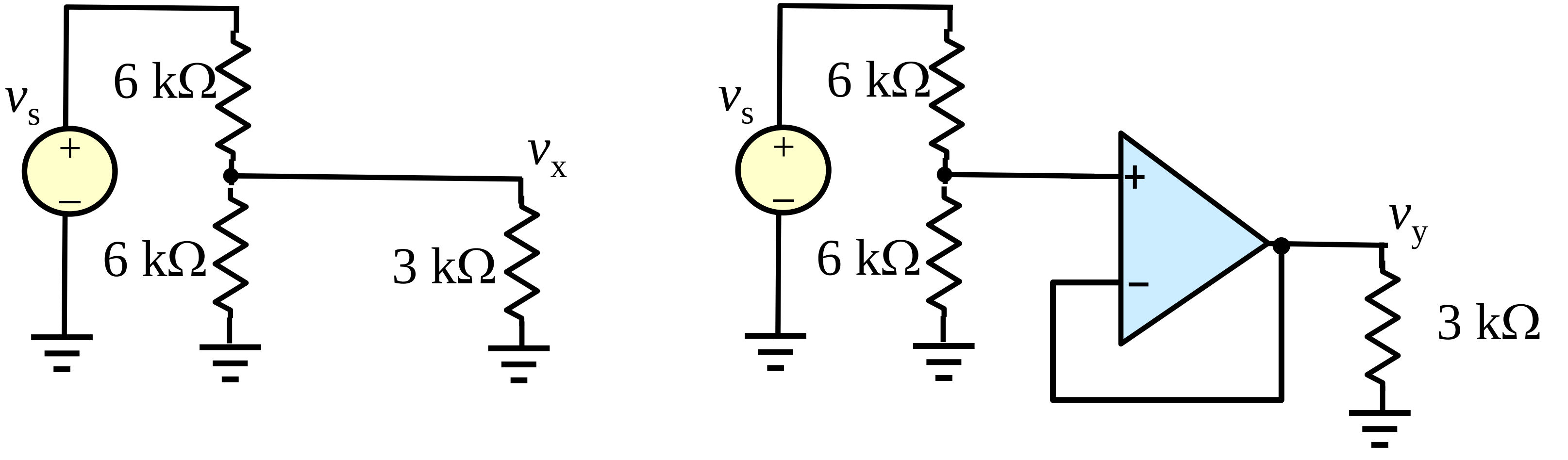
$$\frac{v_{out}}{v_{in}} = A_2 A_1 = -56$$

$$v_{out} = -56 \cdot 20 \text{ mV} = -1.12 \text{ V}$$

Example 1 Multisim

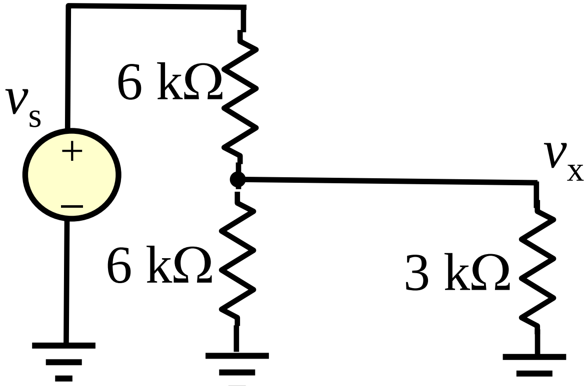


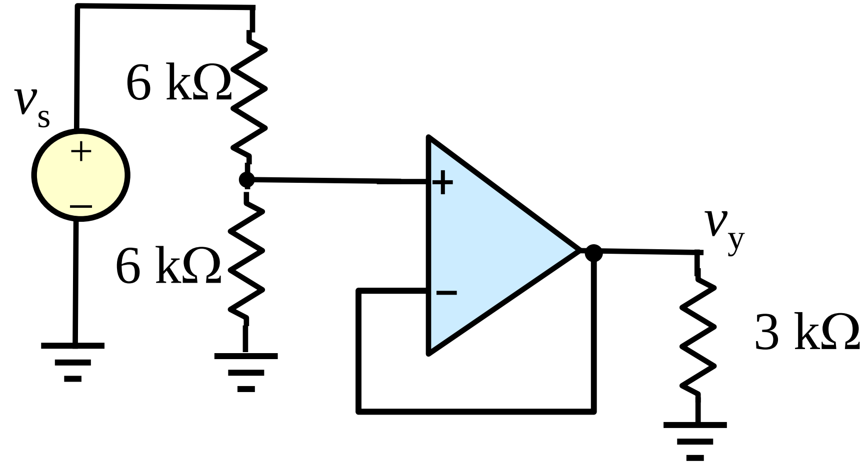
Example 2



Find v_x (left diagram) and v_y (right diagram) if v_s = 12 V.

Example 2 Solution

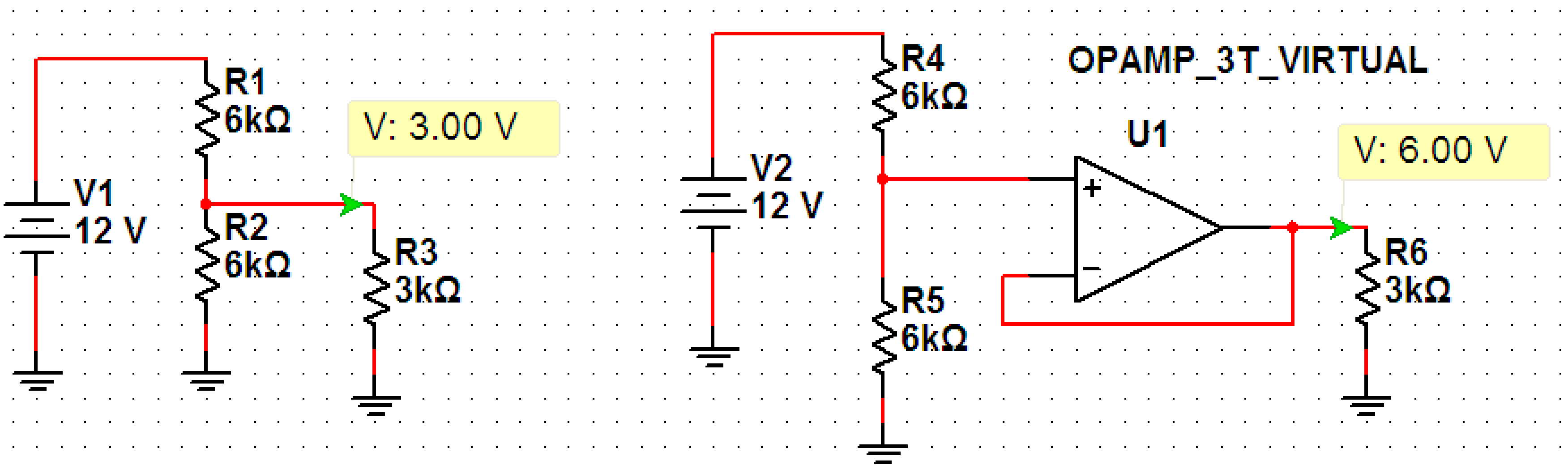




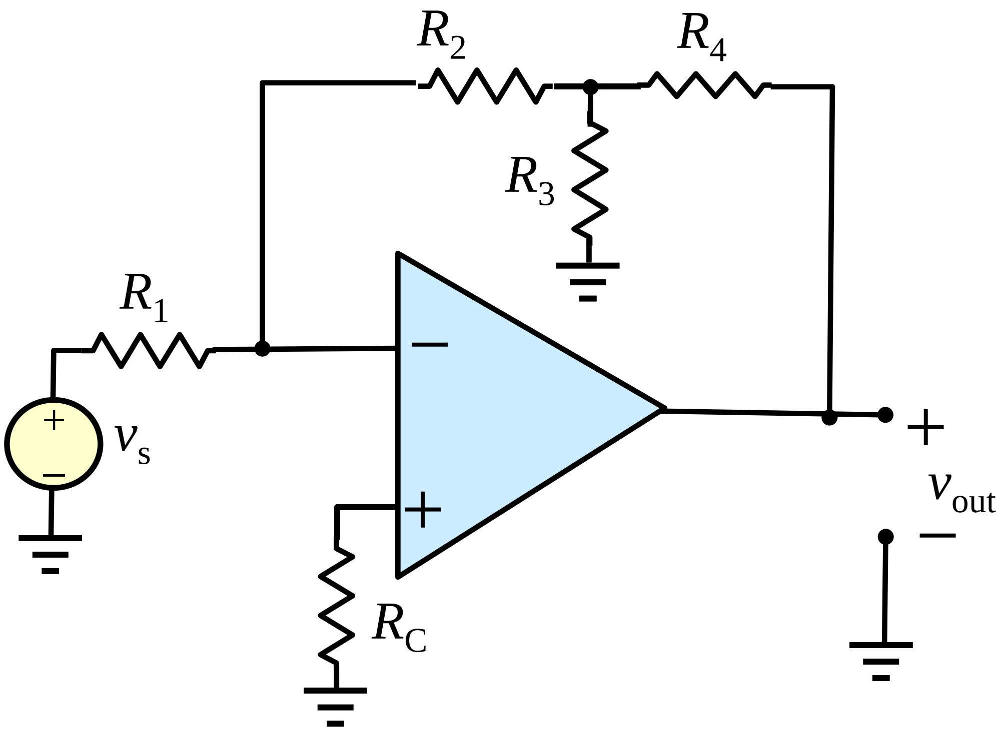
6 kΩ || 3 kΩ = 2 kΩ.
Output is voltage divider.
v_x = 3 V.

Opamp is voltage follower.
Input is voltage divider.
v_y = 6 V

Example 2 Multisim



Example 3



Find the voltage gain if $R_1 = R_3 = 1\ \text{k}\Omega$ and $R_2 = R_4 = 10\ \text{k}\Omega$.

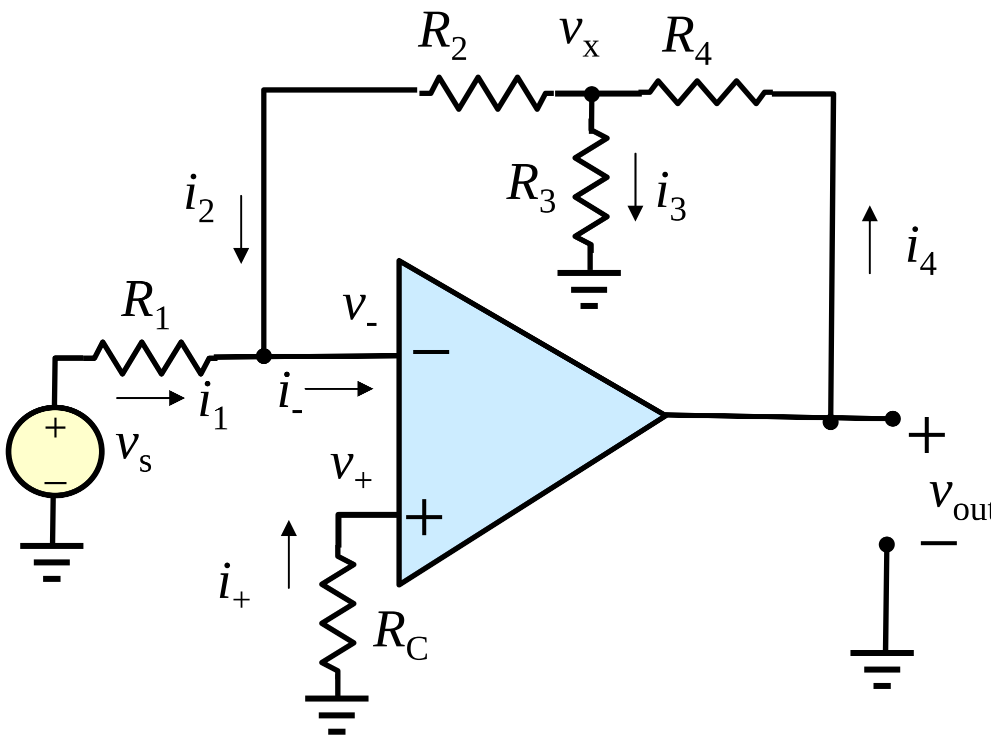
Example 3 Solution (Analytic)

$$i_1 + i_2 = 0$$

$$i_4 - i_2 - i_3 = 0$$

$$\frac{v_s}{R_1} + \frac{v_x}{R_2} = 0$$

$$\frac{v_{out} - v_x}{R_4} - \frac{v_x}{R_2} - \frac{v_x}{R_3} = 0$$



$$\frac{v_s}{R_1} + \frac{v_x}{R_2} = 0$$

$$\frac{v_{out}}{R_4} - v_x\left(\frac{1}{R_4} + \frac{1}{R_2} + \frac{1}{R_3}\right) = 0$$

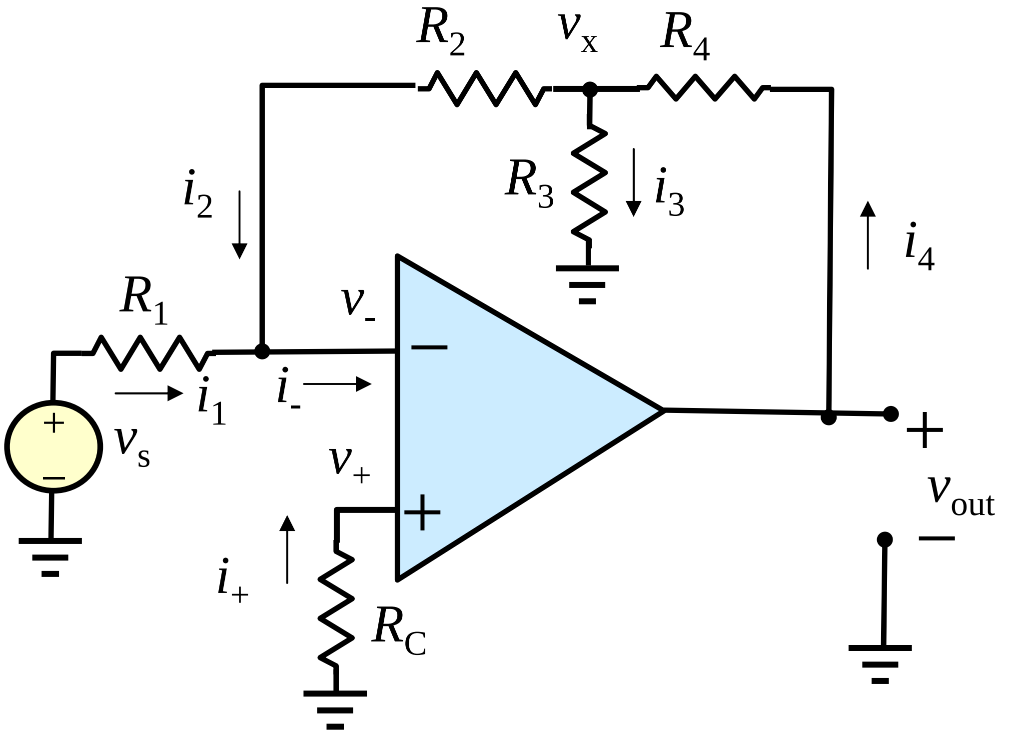
$$v_x = -\frac{R_2}{R_1} v_s$$

$$v_{out} = v_x \frac{R_4}{R_p}$$

$$\boxed{v_{out} = -v_s \frac{R_2}{R_1} \frac{R_4}{R_p}}$$

Example 3 Solution (Numeric)

$$v_{out} = -v_x \frac{R_2}{R_1}\frac{R_4}{R_p}$$



$$\frac{1}{R_p} = \frac{1}{R_4} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_p} = \frac{1}{10} + \frac{1}{10} + \frac{1}{1} = \frac{12}{10}$$

$$A = -\frac{R_2}{R_1}\frac{R_4}{R_p} = -\frac{10}{1}\cdot 10 \cdot \frac{12}{10} = -120$$

Example 3 Multisim