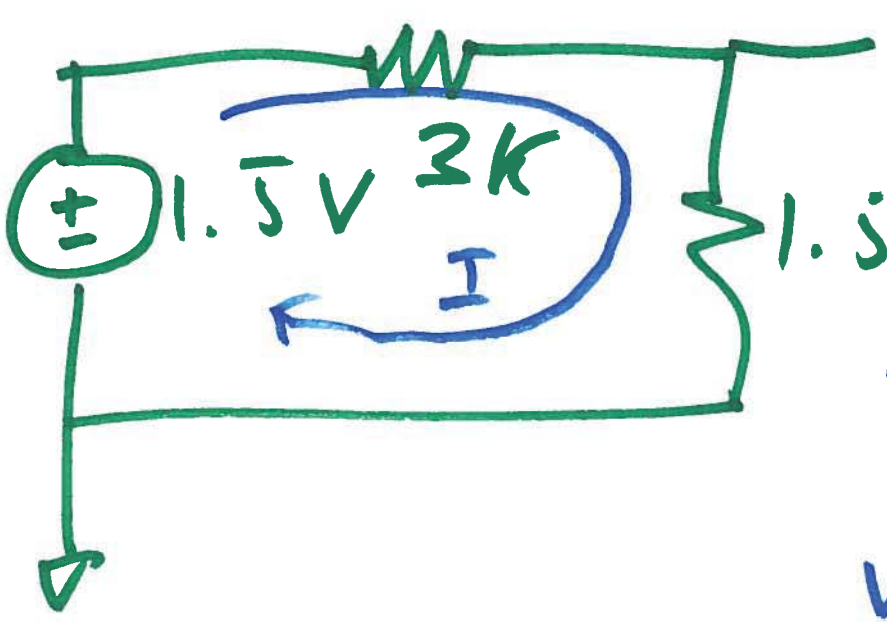
EE 220 circuits I

Lecture 12

OCT. 9, 2017



$$I = \frac{1.5}{3k + 1.5k}$$

$$V_{IN} = I \cdot 1.5k$$

$$V_{IN} = 1.5 \cdot \frac{1.5k}{3k + 1.5k}$$

$$\boxed{V_{IN} = 0.5V}$$

1)

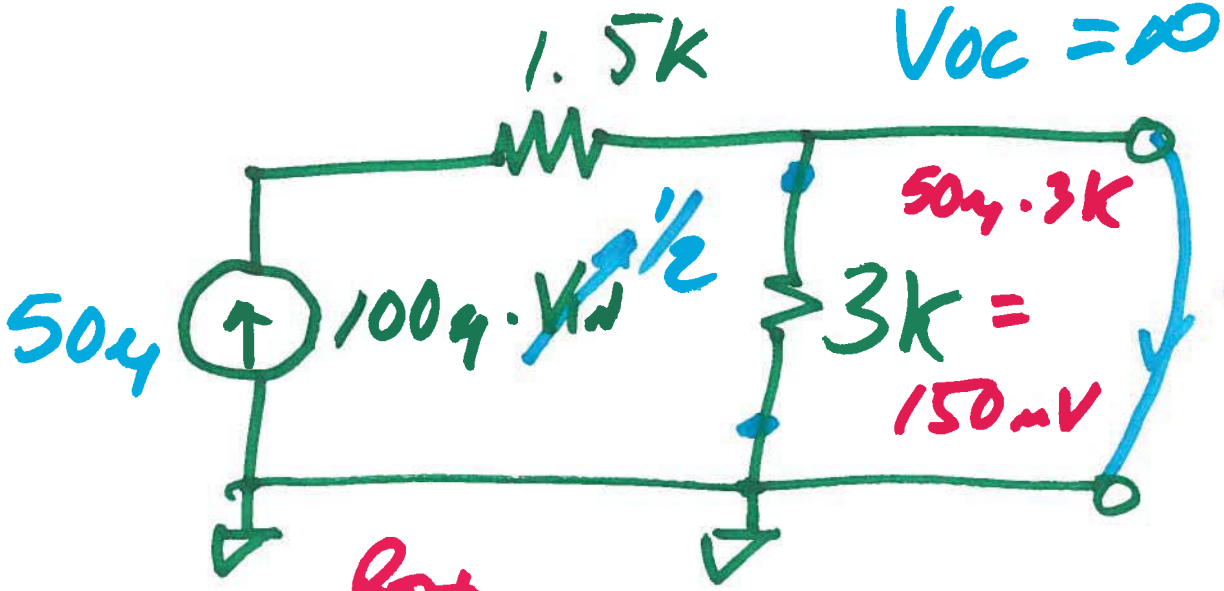
$0.0001 = 1e^{-4} = 0.1e{-}3 = 0.1\,m = 100\,\mu$

1E4

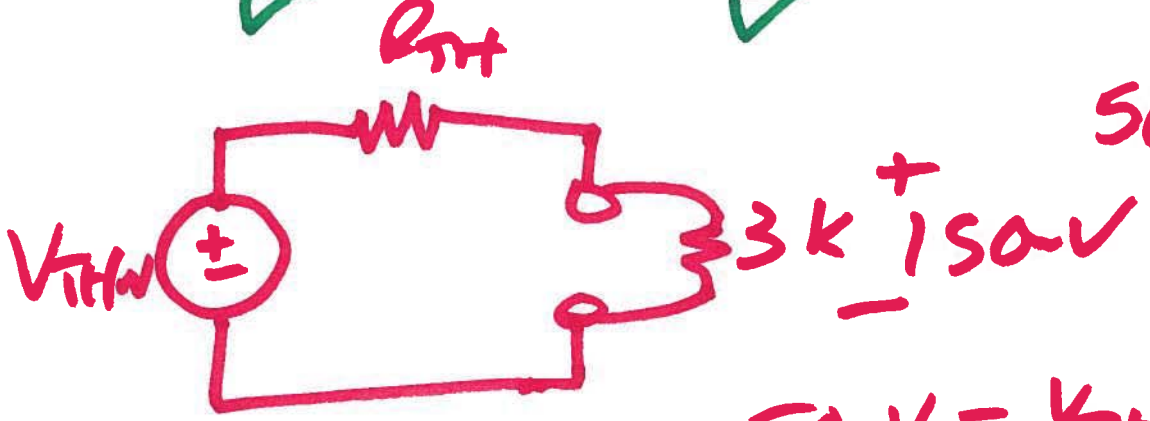
$R_{TH} = \infty$

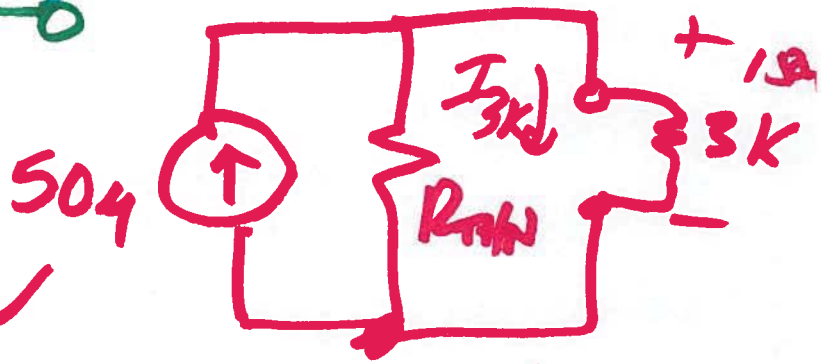
$V_{OC} = \infty$

$I_{sc} = \frac{V_{OC}}{R_{TH}} = \frac{\infty}{\infty}$



$I_{sc} = 50\mu A$





$150mV = V_{ThN} \cdot \frac{3k}{3k + R_{TH}}$

$150mV = I_{3k} \cdot 3k$

$I_{3k} = 50\mu \cdot \frac{R_{ThN}}{R_{ThN} + 3k}$

$$\frac{150\text{mV}}{3\text{K}} = I_{3K} = 50\mu \cdot \frac{R_{TH}}{R_{TH} + 3\text{K}}$$

$$\frac{150 \cdot 10^{-3}}{3 \cdot 10^{3}}$$

$$\frac{150}{3} \cdot \frac{10^{-6}}{10^{0}}$$

$$\frac{150\text{mV}}{3\text{K}} = 50\mu$$

$$50\mu \cdot R_{TH} + 150\text{mV} = 50\mu \cdot R_{TH}$$

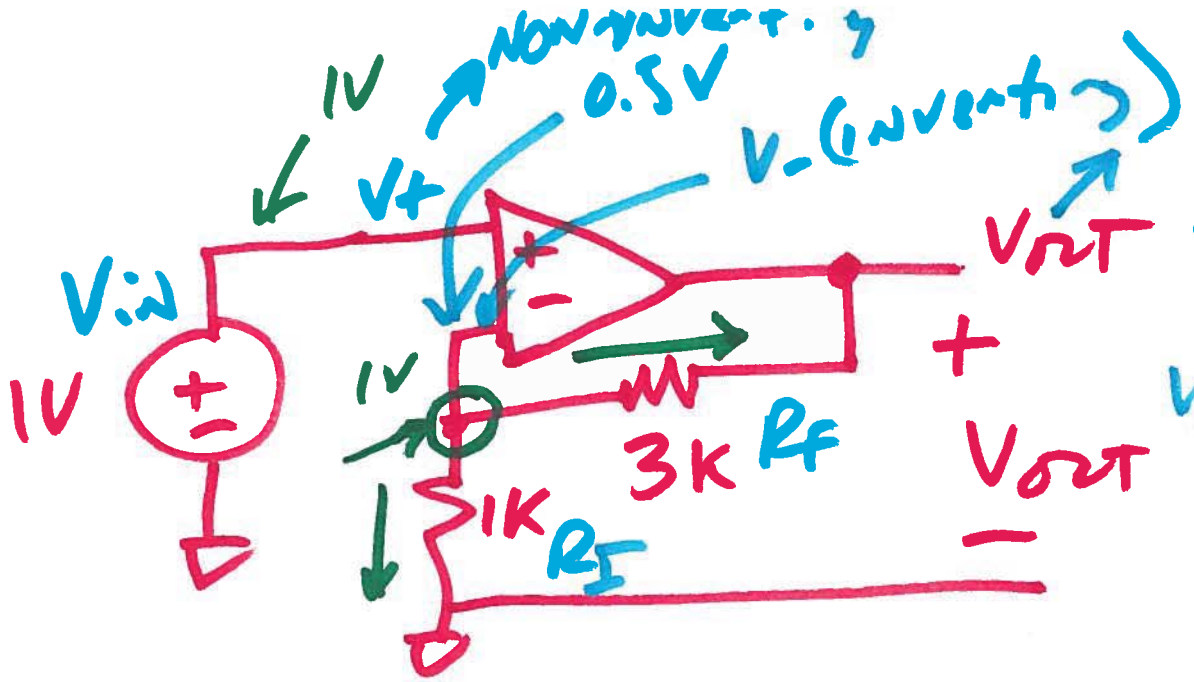
$$150\text{mV} = V_{THN} \cdot \frac{3\text{K}}{3\text{K} + R_{THN}}$$

$$150\text{mV}(3\text{K} + R_{THN}) = V_{THN} \cdot 3\text{K}$$

$$3\text{K} + R_{TH} = V_{THN} \cdot \frac{3\text{K}}{150\text{mV}}$$

$$3\text{K} + R_{THN} = \frac{V_{THN}}{50\mu}$$

$$R_{THN} = \frac{V_{THN}}{50\mu} - 3\text{K}$$



$$V_{OUT} = A_V(V_+ - V_-)$$

$$V_{OUT} = \infty \cdot \left(1 - \frac{1}{1}\right)$$

$$\frac{V_{OUT}}{V_{IN}} = \frac{R_F + R_I}{R_I}$$

$$= 1 + \frac{R_f}{R_I}$$

$$\frac{1V}{1K R_I} + \frac{1 - V_{OUT}}{3K R_F} = 0$$

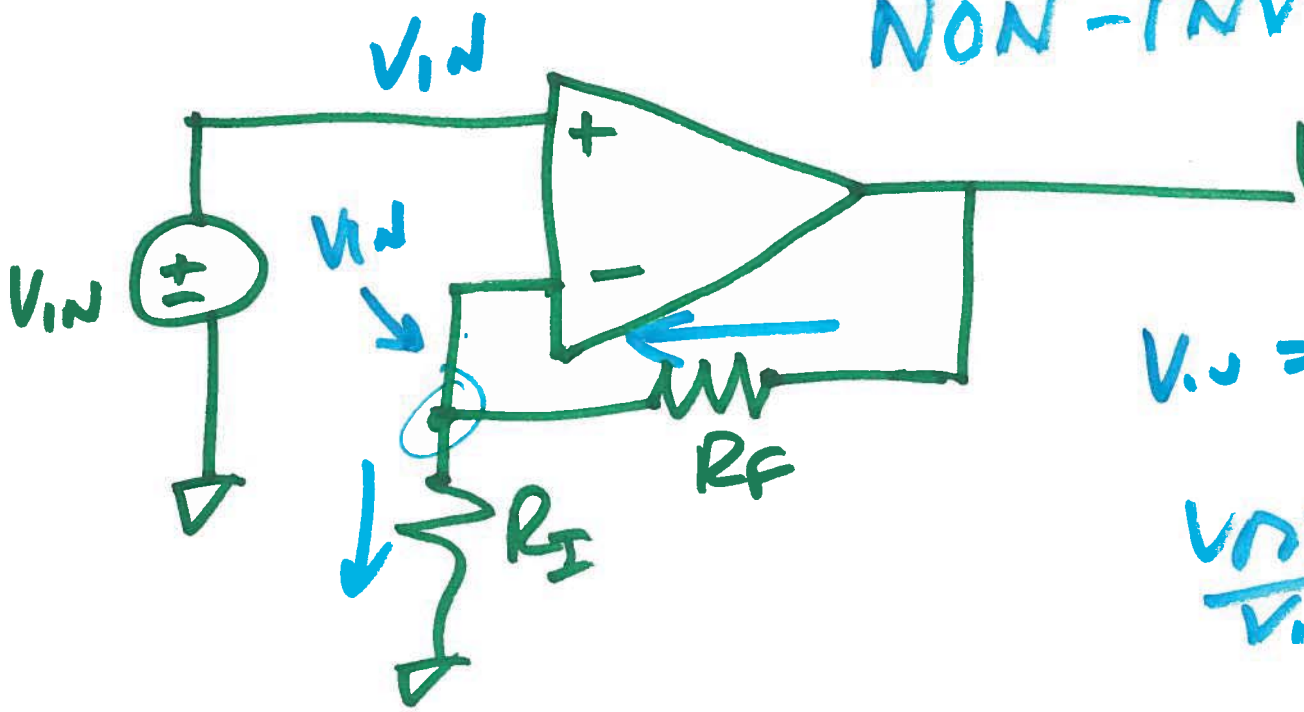
$$3V + 1V - V_{OUT} = 0$$

$$\boxed{V_{OUT} = 4V}$$

MEMORIZE THIS

NON-INVERTING

NON-INVERTING



$$V_{IN} = V_{OUT} \cdot \frac{R_I}{R_I + R_F}$$

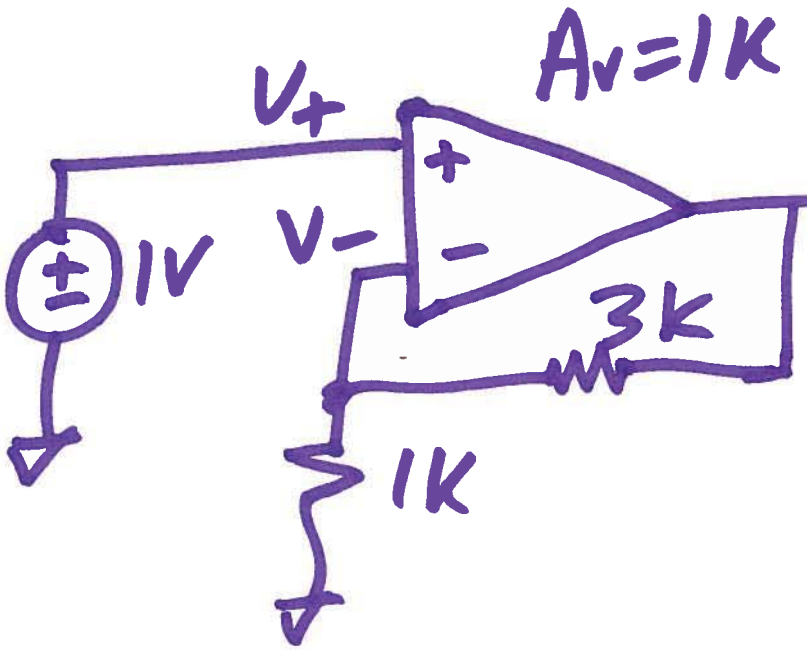
$$\frac{V_{OUT}}{V_{IN}} = \frac{R_I + R_F}{R_I}$$

$$= 1 + \frac{R_F}{R_I}$$

$$\frac{V_{IN}}{R_I} = \frac{V_{OUT} - V_{IN}}{R_F}$$

$$V_{IN}\left(\frac{1}{R_I} + \frac{1}{R_F}\right) = \frac{V_{OUT}}{R_F} \Rightarrow \frac{V_{OUT}}{V_{IN}} = 1 + \frac{R_F}{R_I}$$

NON-ideal op-Amp

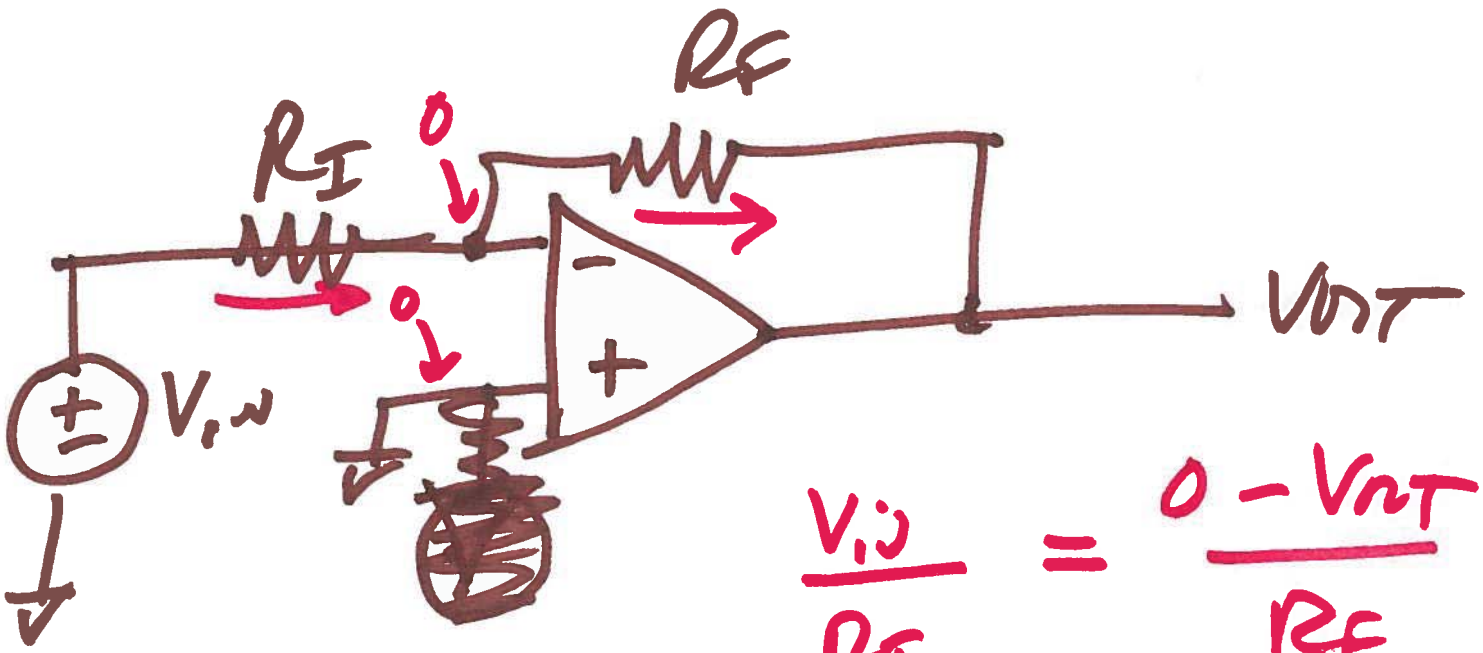


$$V_{OUT} = (V_+ - V_-) \cdot 1K \quad (1V)$$

$$V_- = V_{OUT} \cdot \frac{1k}{1k+3k}$$

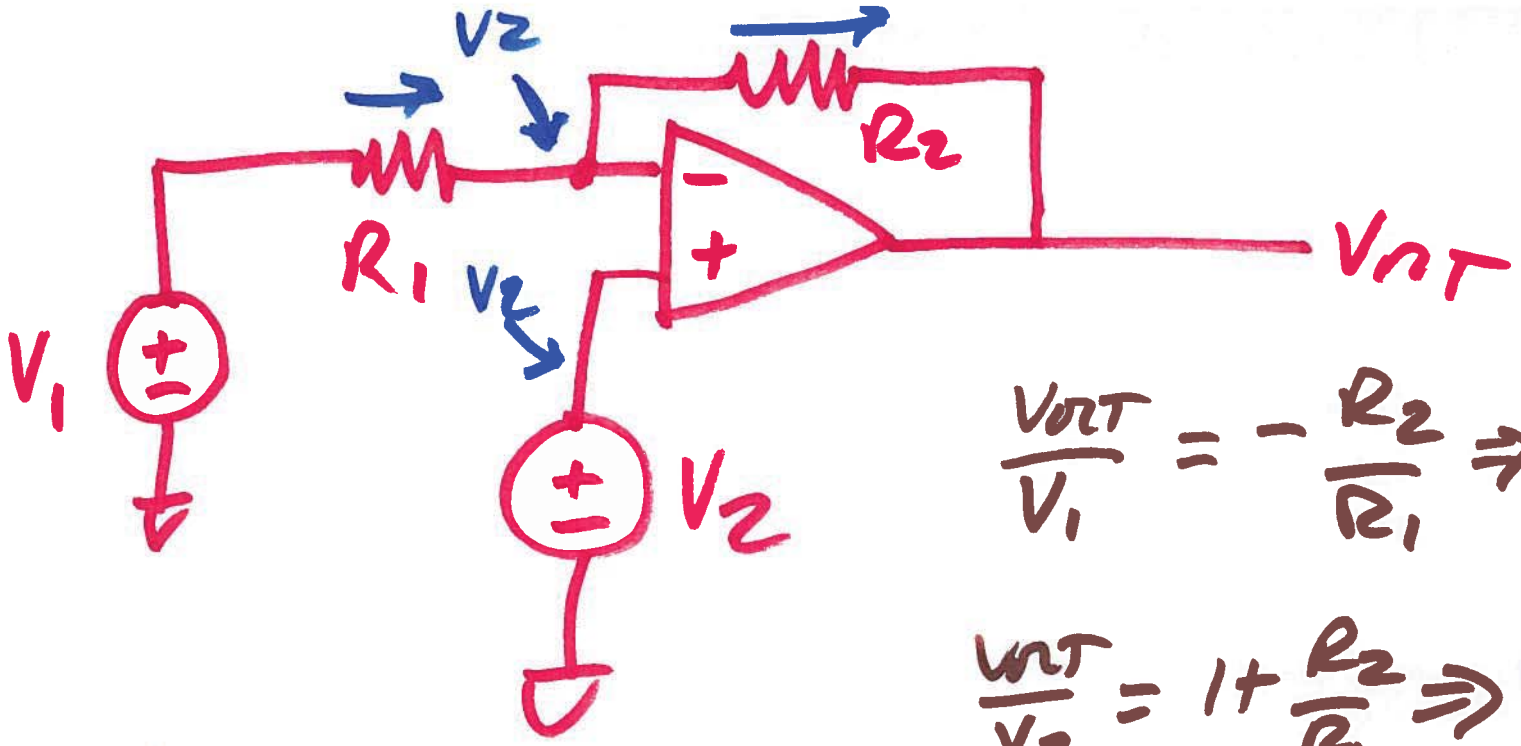
$$V_{OUT} = \left(1 - V_{OUT} \frac{.1k}{1k+3k}\right) .1k$$

Inverting



$$\frac{V_{IN}}{R_I} = \frac{0 - V_{OUT}}{R_F}$$

$$\frac{V_{OUT}}{V_{IN}} = \frac{-R_F}{R_I}$$



$$\frac{V_{OUT}}{V_1} = -\frac{R_2}{R_1} \Rightarrow V_{OUT} = \frac{-R_2}{R_1} \cdot V_1$$

$$\frac{V_{OUT}}{V_2} = 1 + \frac{R_2}{R_1} \Rightarrow V_{OUT} = \left(1 + \frac{R_2}{R_1}\right) V_2$$

$$\frac{V_1 - V_2}{R_1} = \frac{V_2 - V_{OUT}}{R_2}$$

$$V_{OUT} = -\frac{R_2}{R_1} \cdot V_1 + \left(1 + \frac{R_2}{R_1}\right) V_2$$

$$\frac{R_2}{R_1} V_1 - \frac{R_2}{R_1} V_2 = V_2 - V_{OUT}$$

Voltage follower