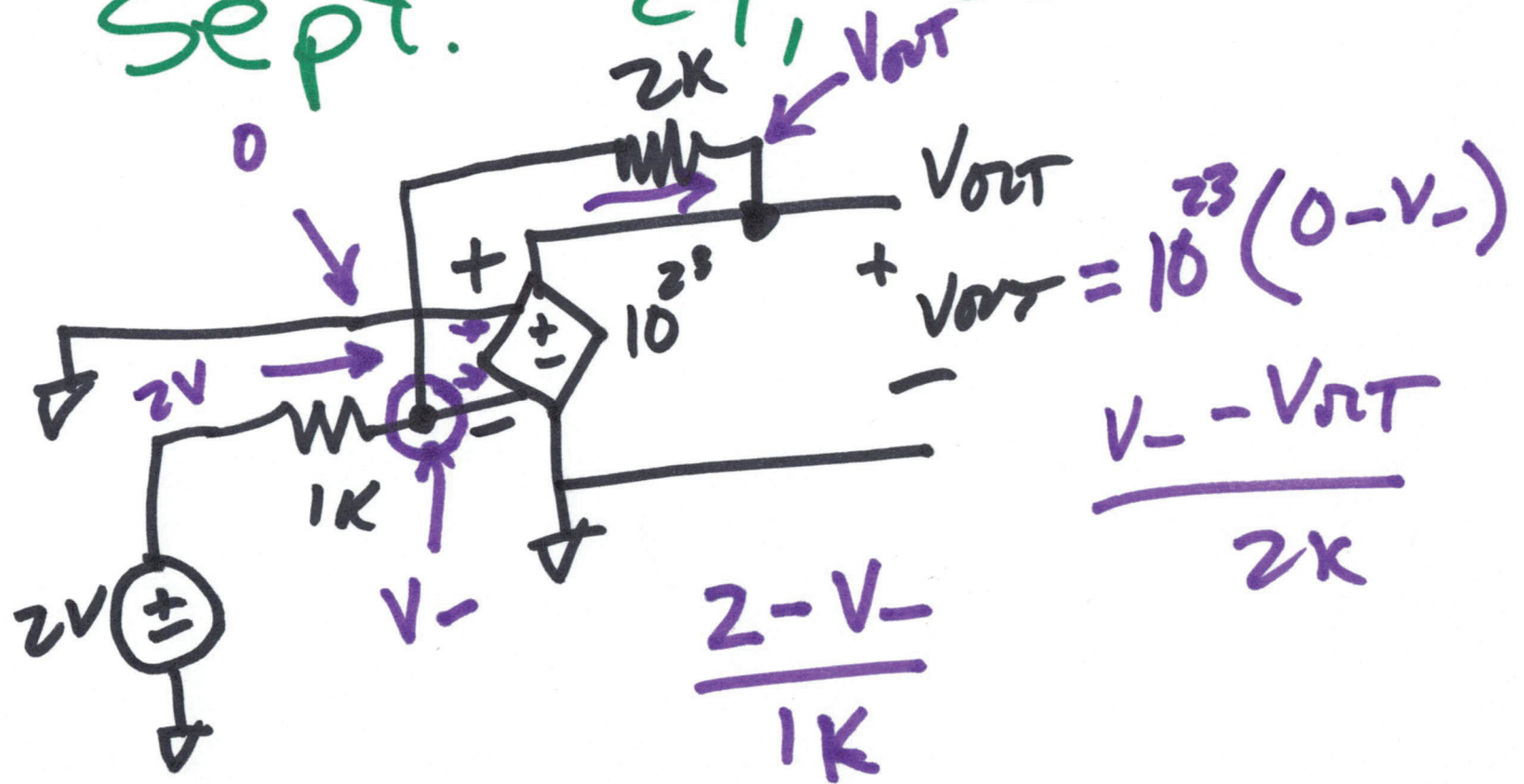


EE 220 Circuits 1

Lecture 11

Sept. 29, 2021



$$\frac{2 - V_-}{1k} = \frac{V_- - V_{out}}{2k}, \quad V_{out} = -10^{+23} V_-$$
$$V_- \downarrow = \frac{V_{out}}{-10^{23}}$$

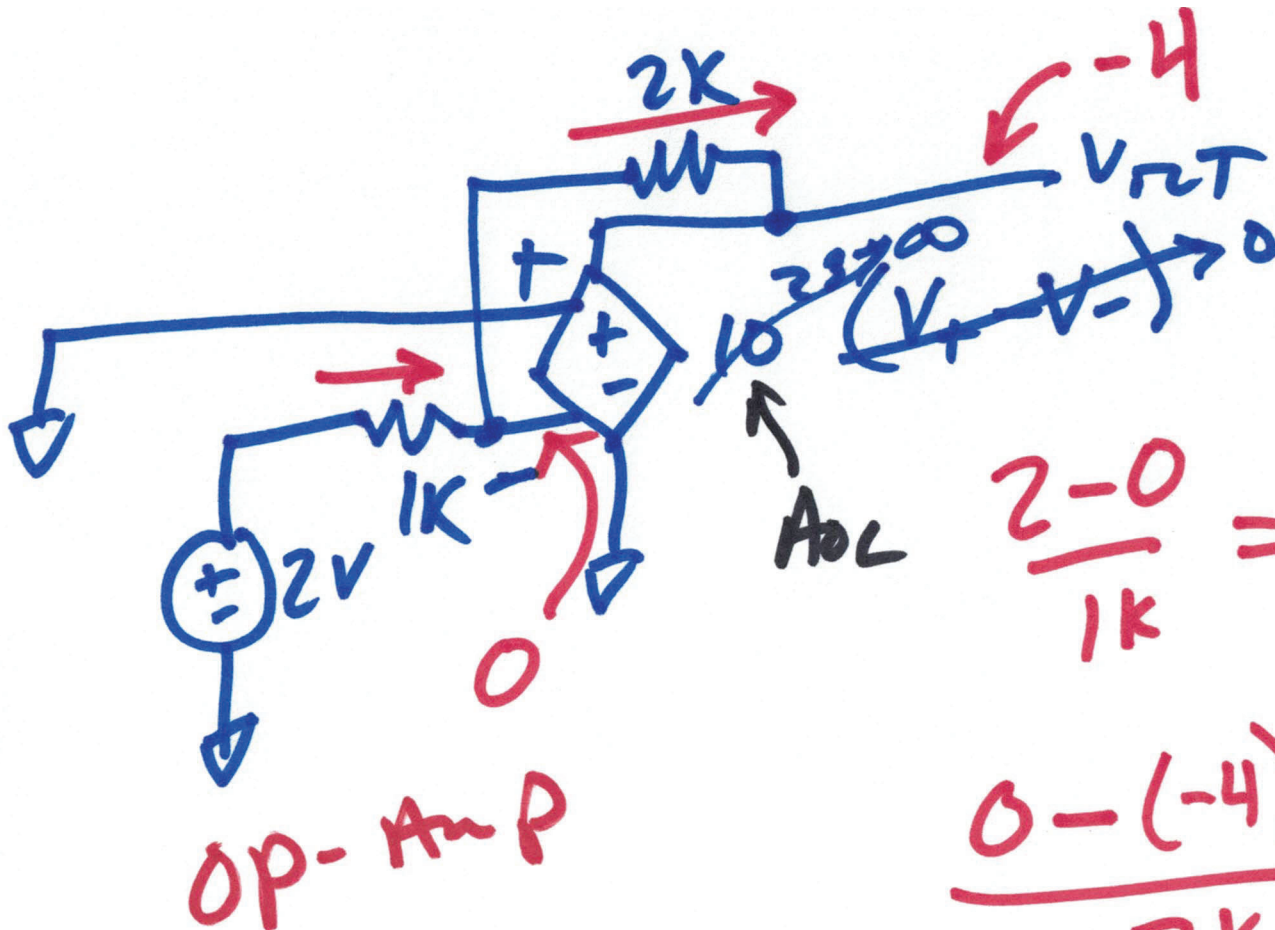
$$4 - 2V_- = V_- - V_{out}$$

$$V_{out} = 3V_- - 4V$$

$$V_{out} = 3 \left(\frac{V_{out}}{-10^{23}} \right) - 4V$$

$$V_{out} \left(1 + \frac{3}{10^{23}} \right) = -4V$$

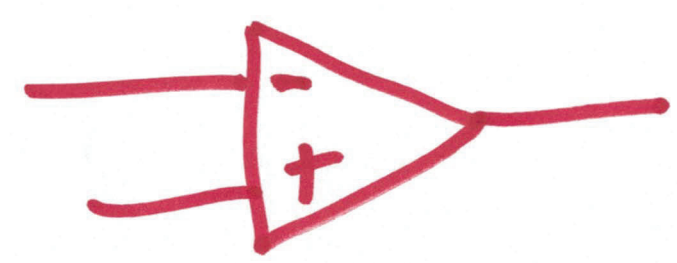
$$\boxed{V_{out} \approx -4V}$$



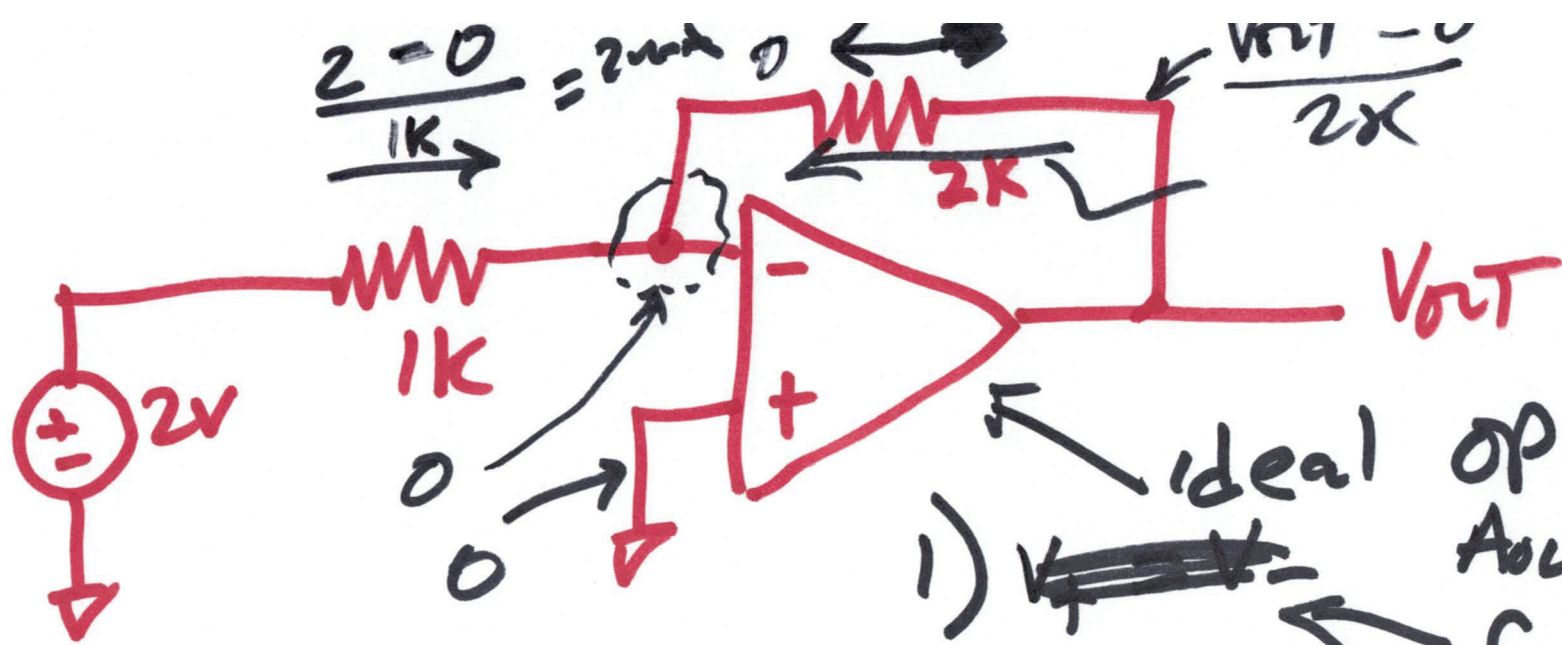
$$\frac{2-0}{1K} = 2\mu A$$

$$\frac{0-(-4)}{2K} = 2\mu A$$

OP-AMP



37



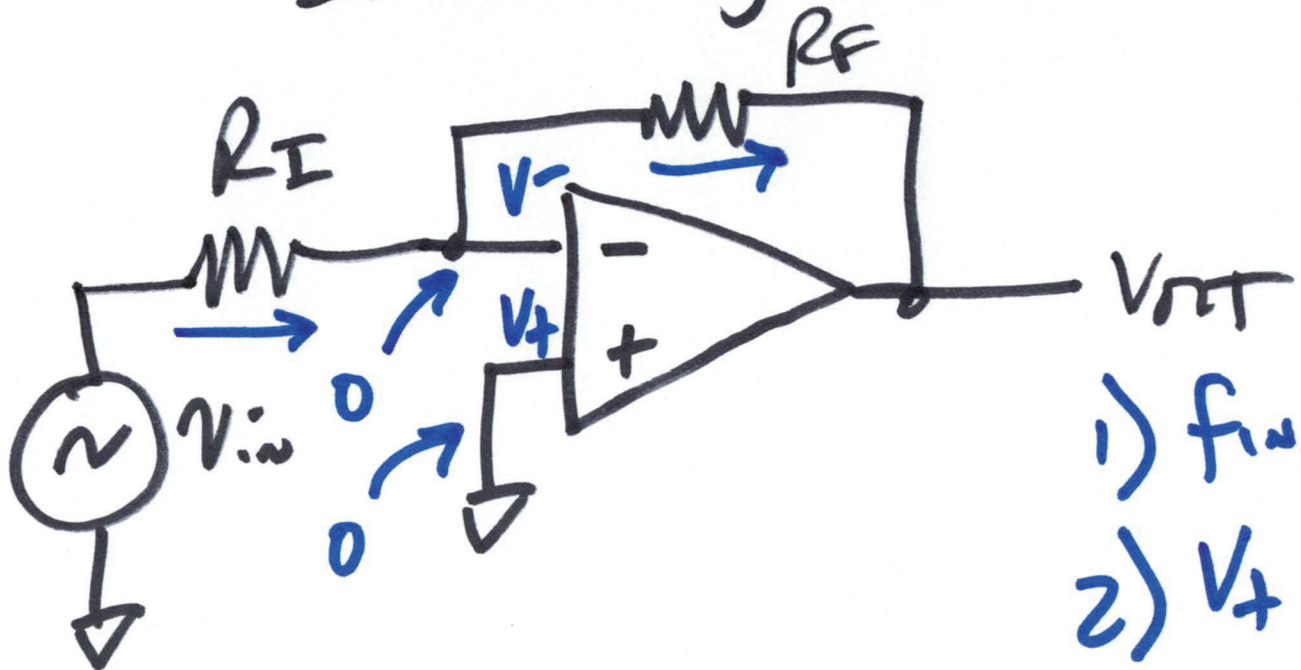
$$\frac{2-0}{1k} + \frac{V_{out}-0}{2k} = 0$$

$$V_{out} = -4V$$

- ideal op-amp
 $A_{OL} \rightarrow \infty$
 1) ~~$V_+ = V_-$~~ find V_+
 2) $V_+ = V_-$
 3) KCL @ - input

- \Rightarrow MINUS INPUT \Rightarrow INVERTING INPUT
 + \Rightarrow PLUS INPUT \Rightarrow NON-INVERTING INPUT

Inverting Amplifier

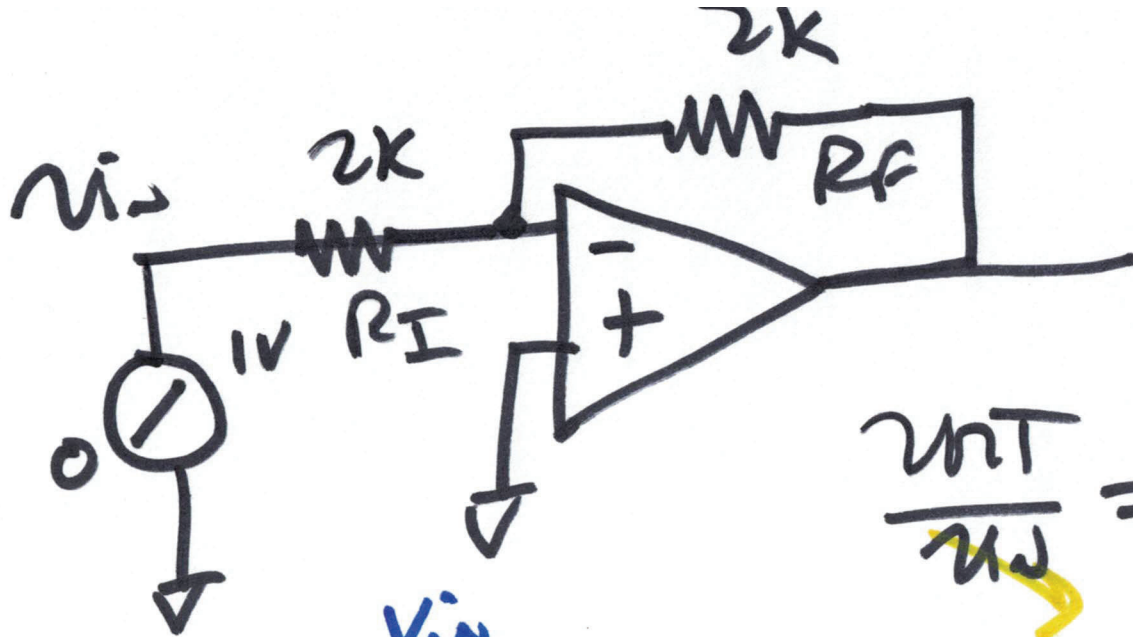


- 1) find v_+
- 2) $v_+ = v_-$

$$\frac{v_{in} - 0}{R_I} = \frac{0 - v_{out}}{R_F}$$

$$\frac{v_{out}}{v_{in}} = -\frac{R_F}{R_I}$$

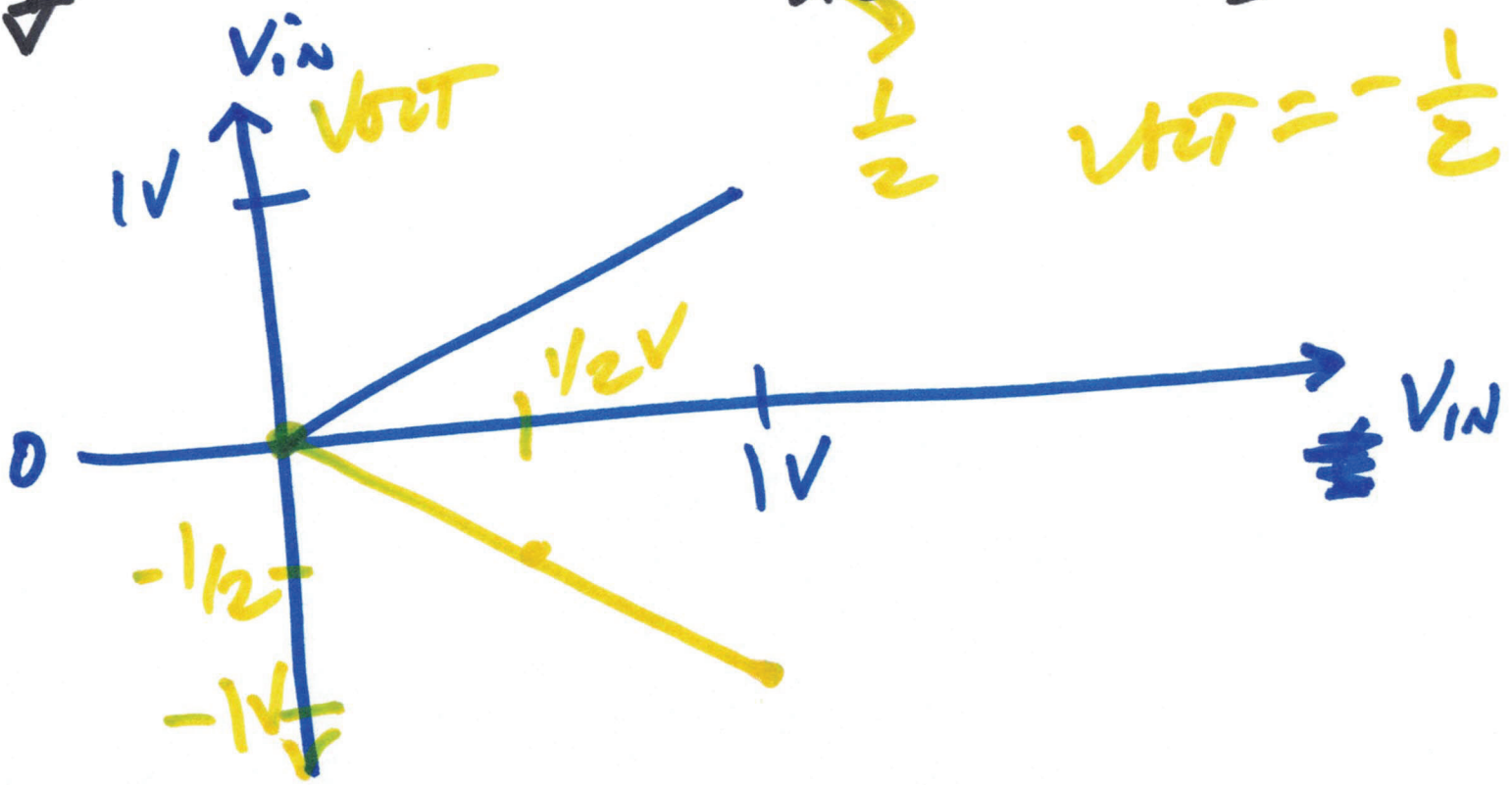
5)



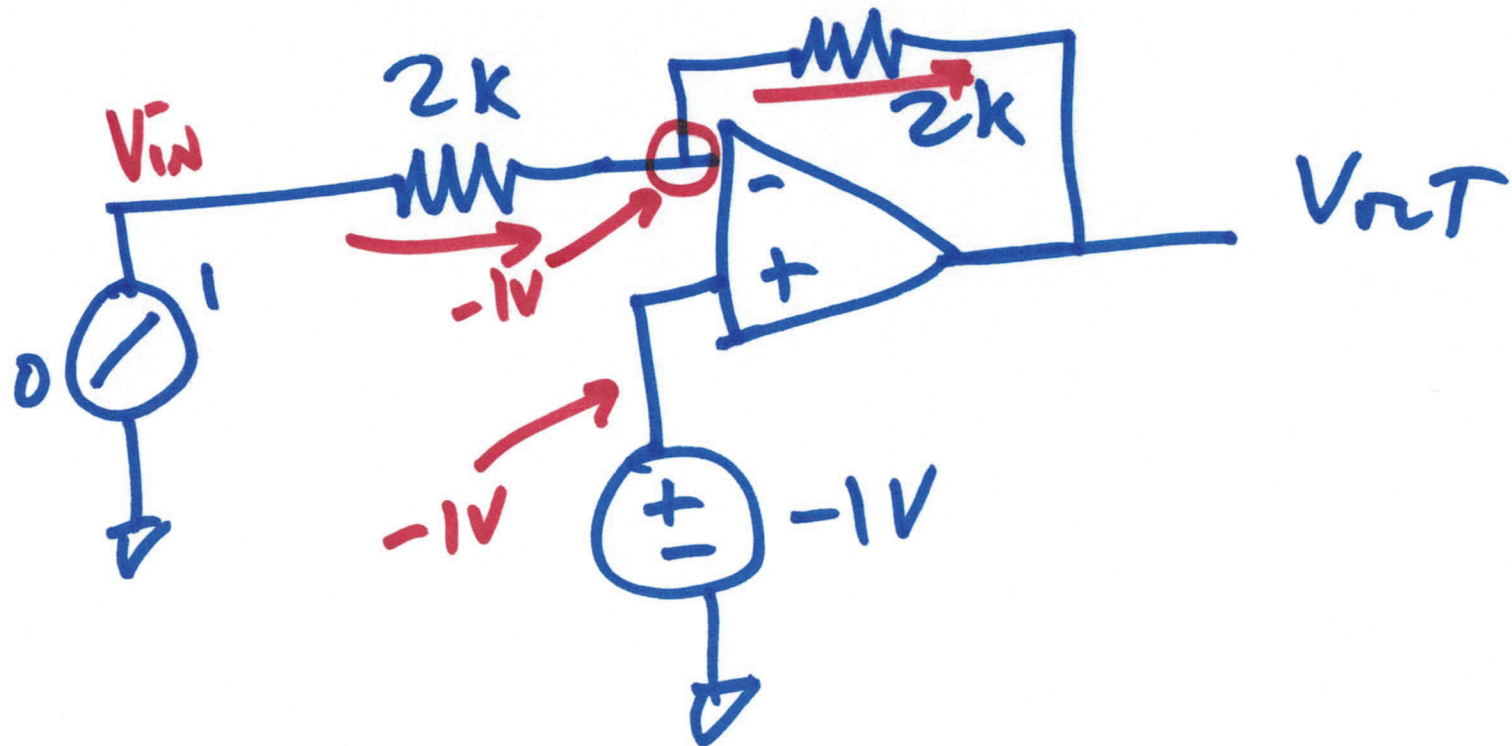
$$v_{OUT} =$$

$$\frac{v_{OUT}}{v_{IN}} = -\frac{R_F}{R_I} = -1$$

$$v_{OUT} = -\frac{1}{2} v_{IN}$$



6)



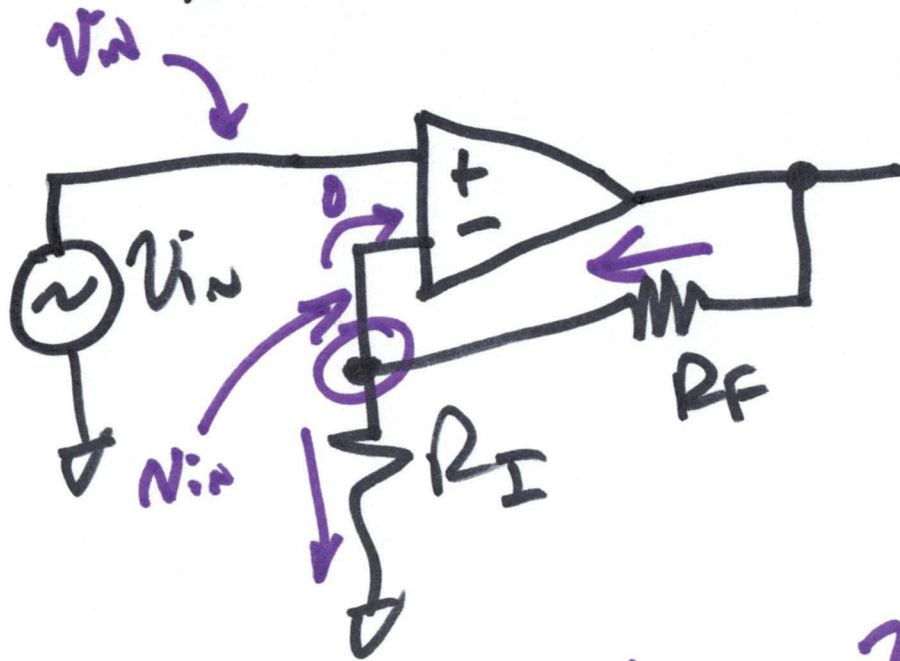
$$\frac{V_{in} - (-1)}{2k} = \frac{-1 - V_{out}}{2k}$$

$$V_{in} + 2 = -V_{out} - 2$$

$$V_{out} = -V_{in} - 2$$



NON-INVERTING

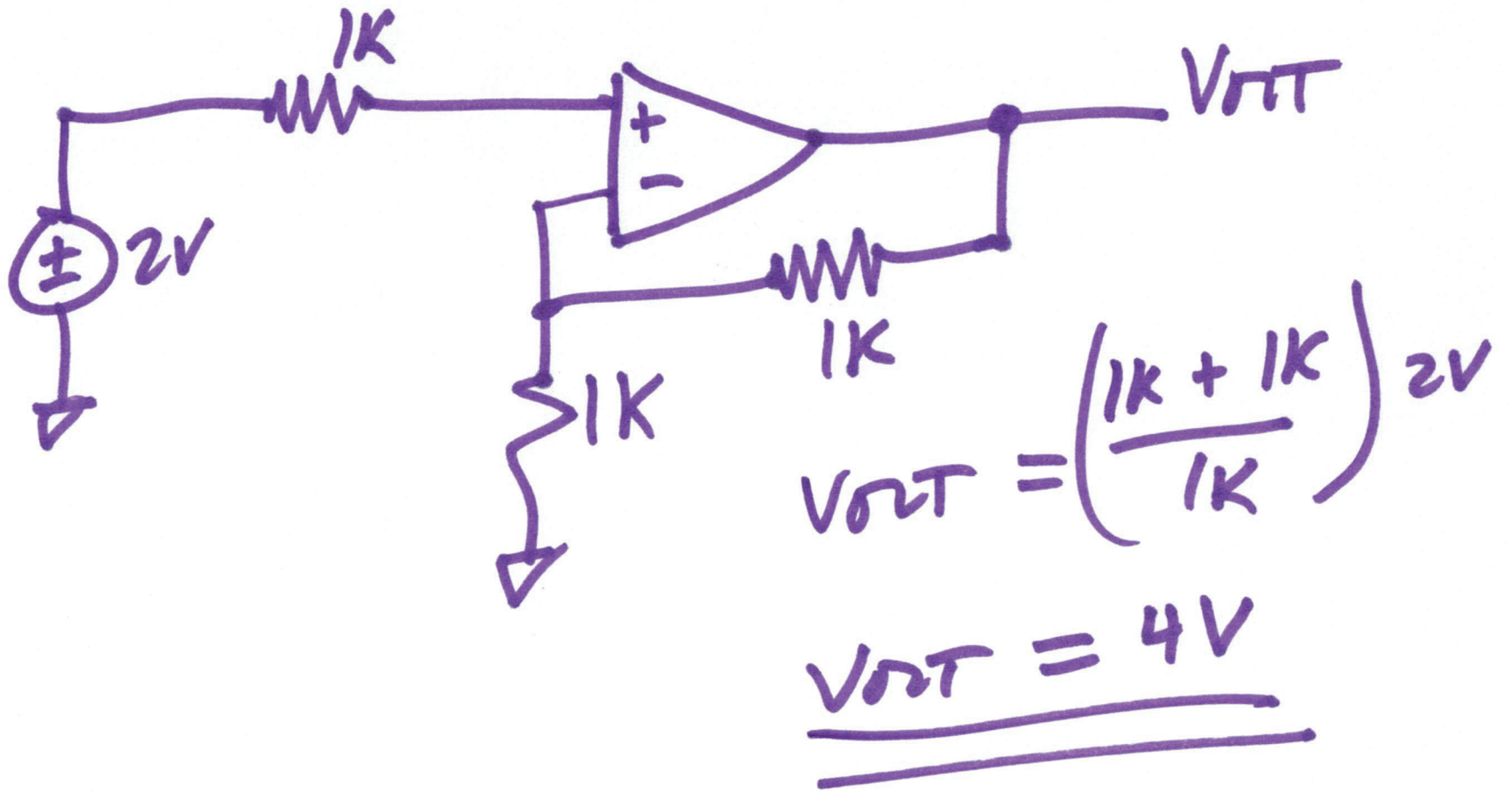


BURN INTO YOUR BRAIN!

$$\frac{v_{in}}{R_I} = \frac{v_{OUT} - v_{in}}{R_F}$$

$$v_{in} \left(\frac{1}{R_I} + \frac{1}{R_F} \right) = \frac{v_{OUT}}{R_F}$$

$$\frac{v_{OUT}}{v_{in}} = 1 + \frac{R_F}{R_I} = \frac{R_I + R_F}{R_I}$$



a)