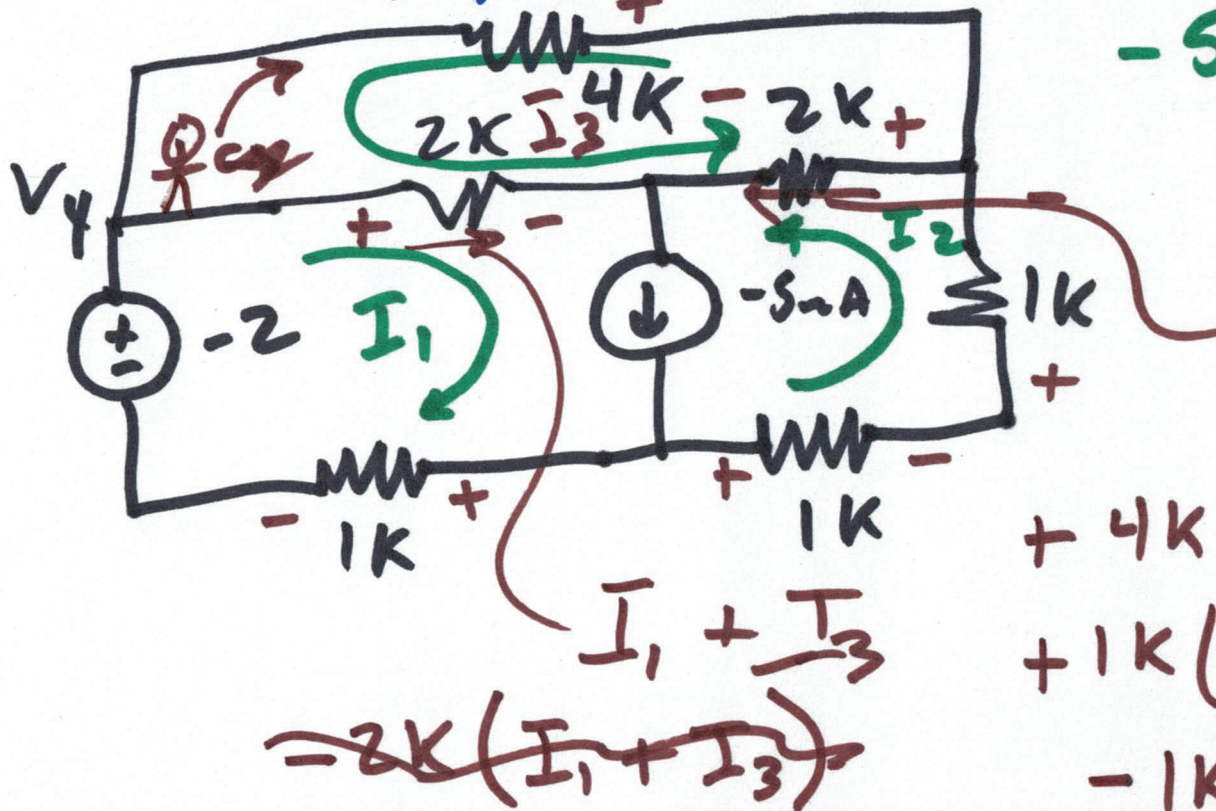


EE 221 CIRCUITS II

$$+ 4kI_3 + 2k(I_1 + 5mA + I_3) + 2k(I_1 + I_3) = 0$$

Lecture 5

February 1, 2023



$$-5mA = I_1 + I_2$$

$$I_2 = -I_1 - 5mA$$

$$-I_1 - 5mA - I_3$$

$$+ 4kI_3 + 1k(-I_1 - 5mA)$$

$$+ 1k(-I_1 - 5mA)$$

$$- 1kI_1 + (-2) = 0$$

$$4kI_3 + 2k(-I_1 - 5mA) - 1kI_1 - 2 = 0$$

$$-3kI_1 + 4kI_3 - 12 = 0$$

$$4kI_1 + 8kI_3 + 10 = 0$$

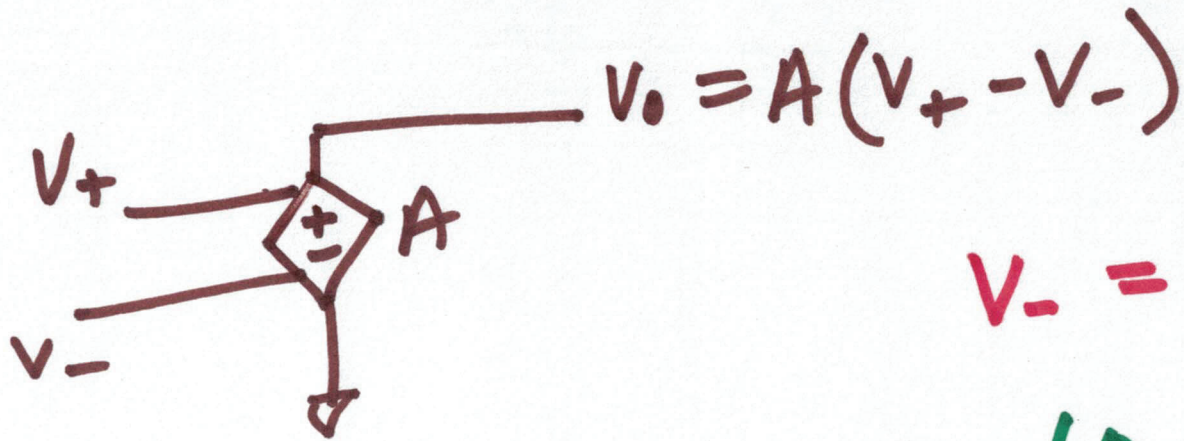
$\times (-2)$

$$6kI_1 - 8kI_3 + 24 = 0$$

\rightarrow

$$10kI_1 + 34 = 0$$

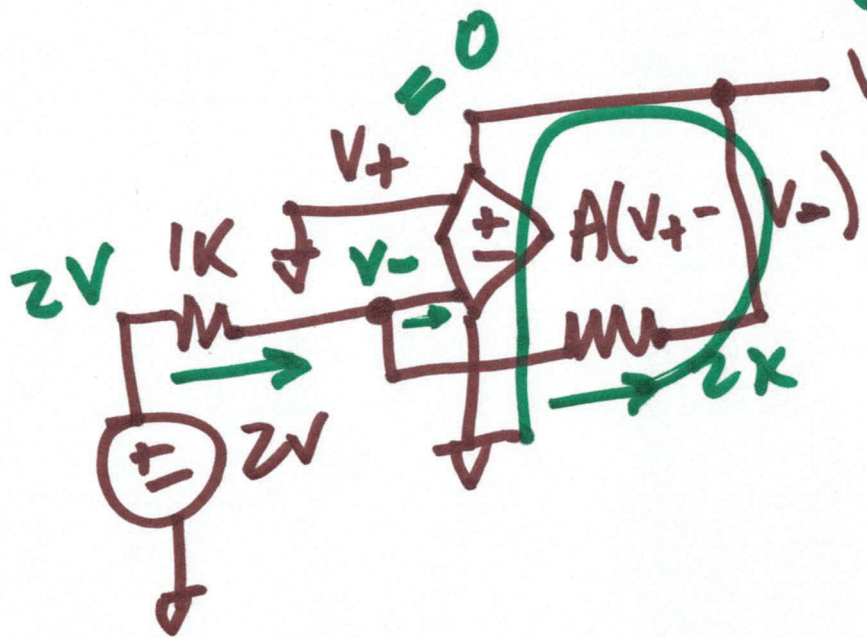
$$I_1 = -3.4 \text{ mA}$$



$$V_- = \frac{V_{OUT}}{A}$$

$$V_{OUT} = A(0 - V_-)$$

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



$$\frac{2 - V_-}{1k} = \frac{V_- - V_{OUT}}{2k}$$

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

$$4 - 2V_- = V_- + AV_-$$

$$V_- = -\frac{V_{out}}{A}$$

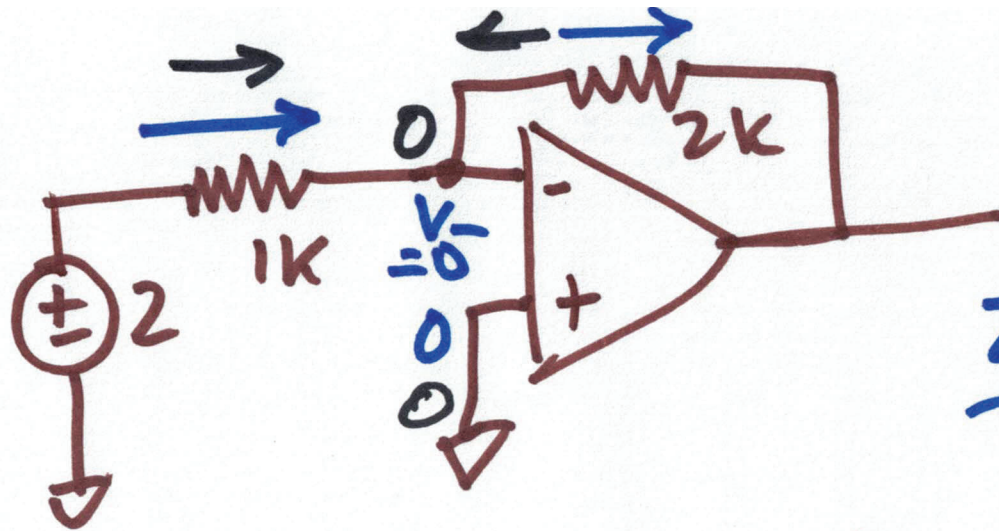
$$\rightarrow 4 = V_- + AV_- + 2V_-$$

$$4 = V_- (1 + A + 2)$$

$$-4 = V_{out} \left(\frac{1}{A} + 1 + \frac{2}{A} \right)$$

$$A \rightarrow \infty$$

$$V_{out} = -4$$



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

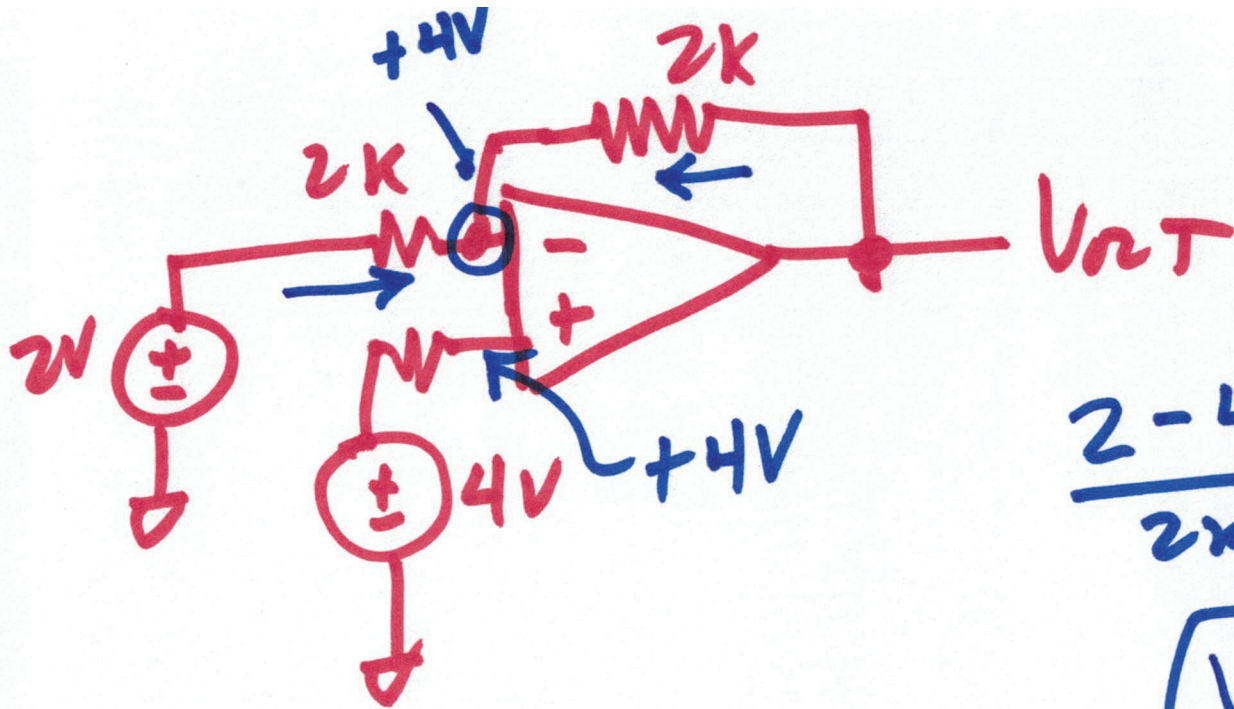
$$\frac{2 - V_-}{1k} = \frac{V_- - V_{out}}{2k}$$

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

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

$$V_{out} = -4$$

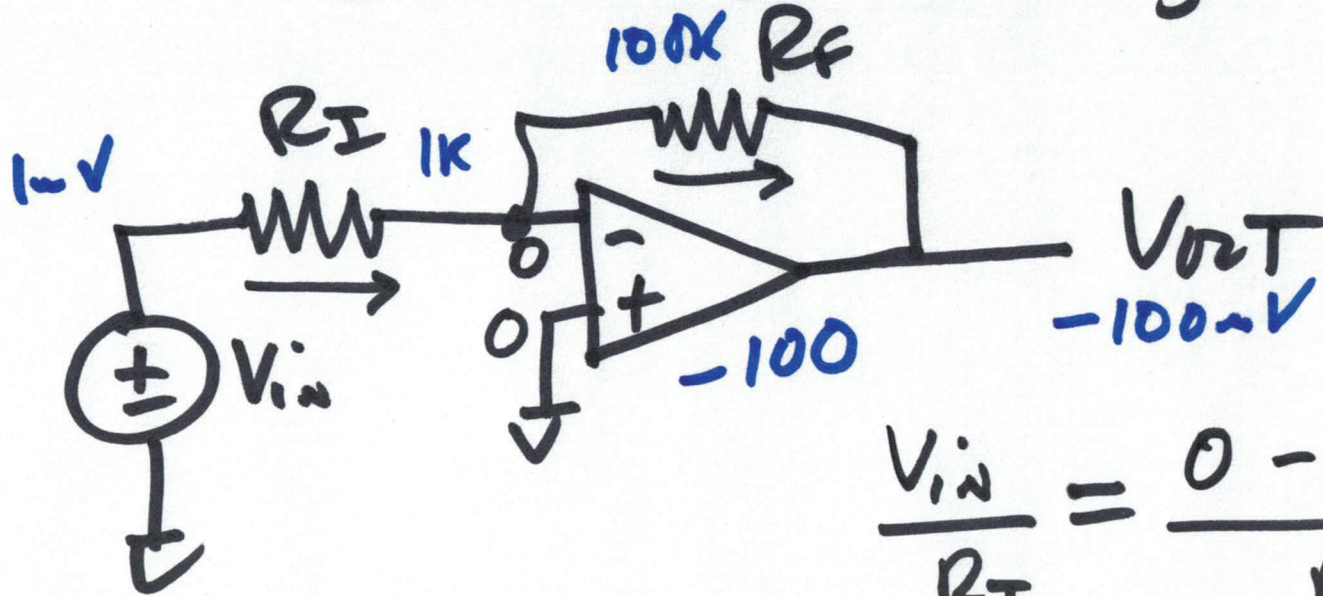
- 1) Determine V_+
- 2) Set $V_+ = V_-$
- 3) KCL @ - INPUT



$$\frac{2-4}{2k} + \frac{V_{out}-4}{2k} = 0$$

$$V_{out} = 6V$$

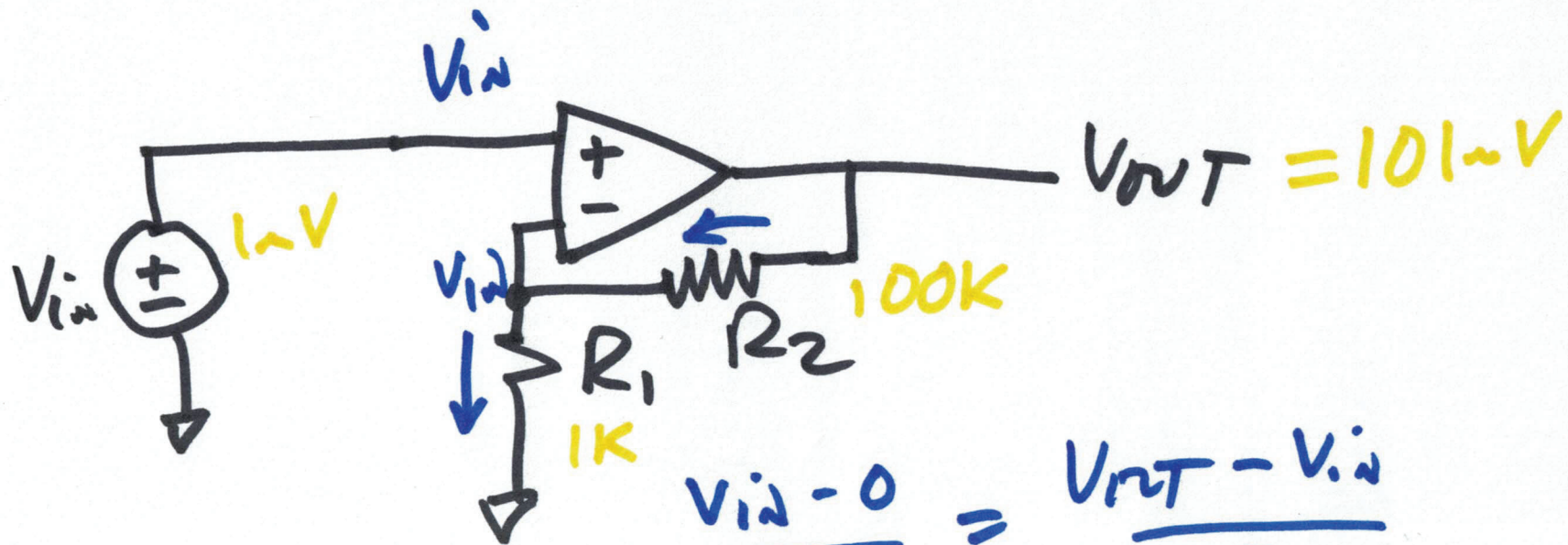
Inverting Topology



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

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

NON-INVERTING TOPOLOGY



$$\frac{V_{in} - 0}{R_1} = \frac{V_{out} - V_{in}}{R_2}$$

$$\frac{R_2}{R_1} \cdot V_{in} = V_{out} - V_{in}$$

$$\left(\frac{R_2}{R_1} + 1 \right) V_{in} = V_{out}$$

$$\frac{V_{out}}{V_{in}} = 1 + \frac{R_2}{R_1} = \frac{R_1 + R_2}{R_1}$$

