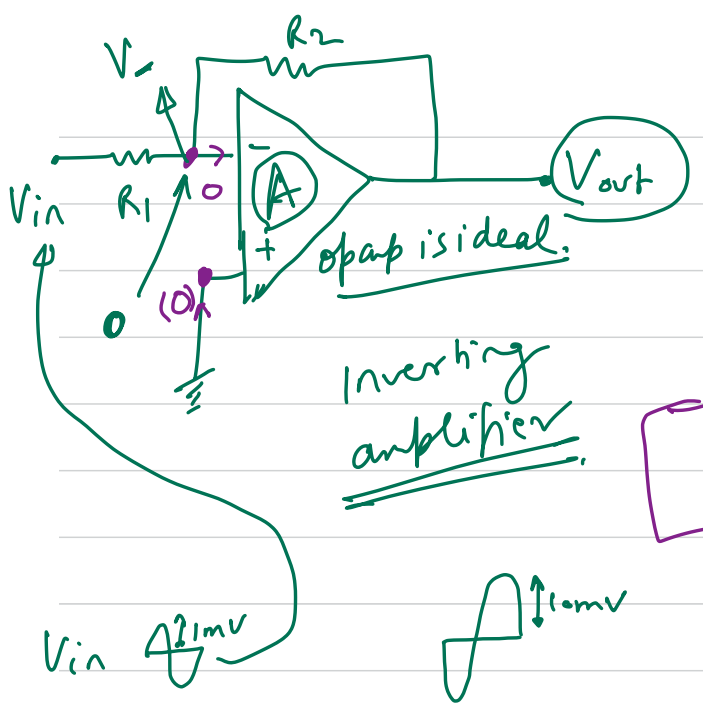


$V_+ = V_- = 0$

$A = \infty$, $i = 0$, $V_+ = V_-$

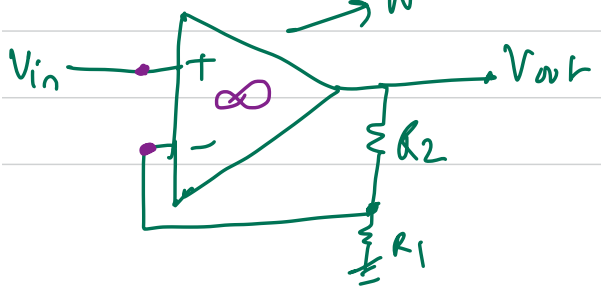
$$V_-\left\{\frac{1}{R_1} + \frac{1}{R_2}\right\} - \frac{V_{in}}{R_1} - \frac{V_{out}}{R_2} = 0$$

Inverting amplifier

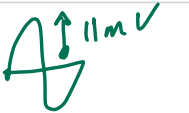
$$\left\{\frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1}\right\} = \frac{-10R_1}{R_1}$$

$V_+ - V_- = 30mV$

$= (-10)$ $A \to \infty$

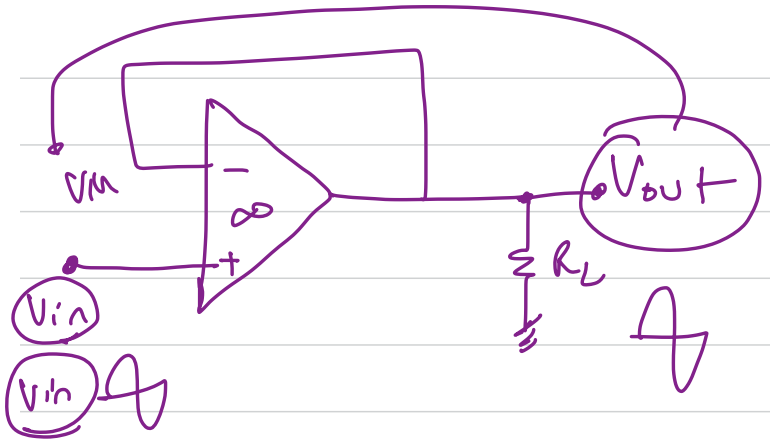


$$\frac{V_{out}}{V_{in}} = \left(1 + \frac{R_2}{R_1}\right) = (11)$$



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

$(V_+ = V_-)$

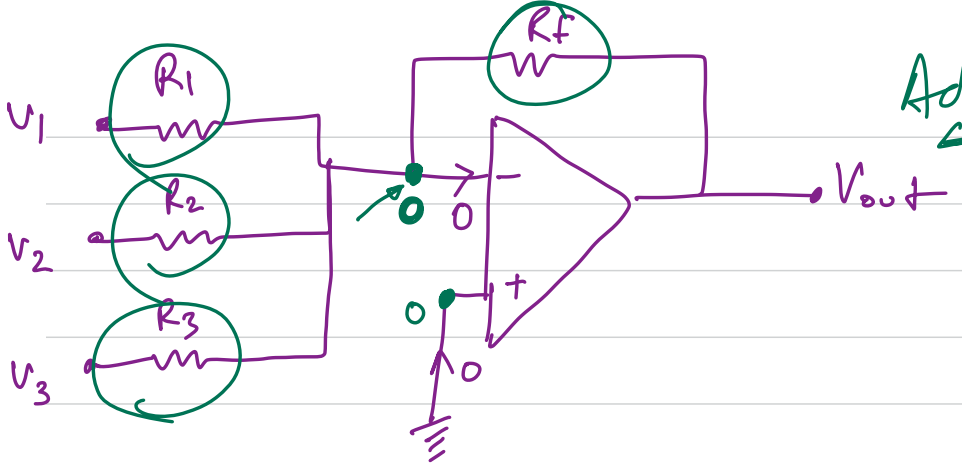


$(V_{out} = V_{in})$

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

Unity gain follower

$V_{out} = (10\tilde{V}_1 + 20\tilde{V}_2) = \alpha V_1 + \beta V_2$



Adder / Summer

$R_1 = R_f$

$R_2 = R_f/2$

$R_3 = R_f/3$

$R_f = 1^{R_1}$

$R_f = 2^{R_2}$

$R_f = 3^{R_3}$

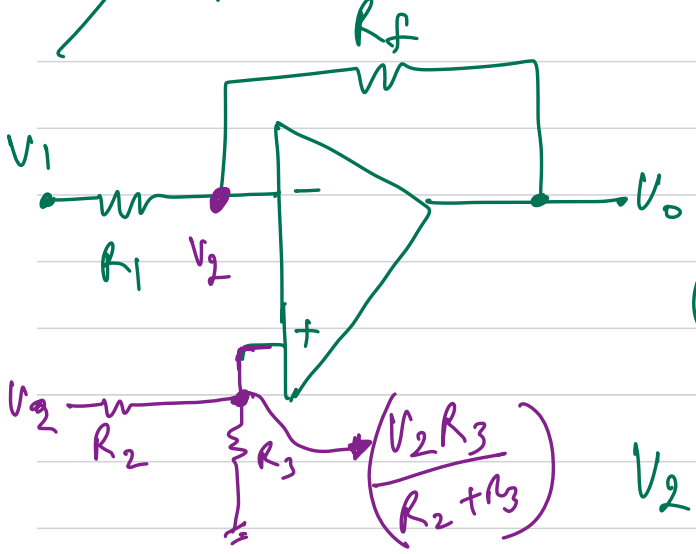
$$V_- \left\{ \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_f} \right\} - \frac{V_1}{R_1} - \frac{V_2}{R_2} - \frac{V_3}{R_3} - \frac{V_{out}}{R_f} = 0$$

$V_- = 0$

$$V_{out} = -\left(\frac{R_f}{R_1} V_1 + \frac{R_f}{R_2} V_2 + \frac{R_f}{R_3} V_3 \right)$$

$$= -\left(\alpha V_1 + \beta V_2 + \gamma V_3 \right) = -\left(1V_1 + 2V_2 + 3V_3 \right)$$

$$V_{out}(t) = V_1(t) + 2V_2(t) + 3V_3(t)$$



$$V_- \left\{ \frac{1}{R_1} + \frac{1}{R_2} \right\} - \frac{V_1}{R_1} - \frac{V_{out}}{R_f} = 0$$

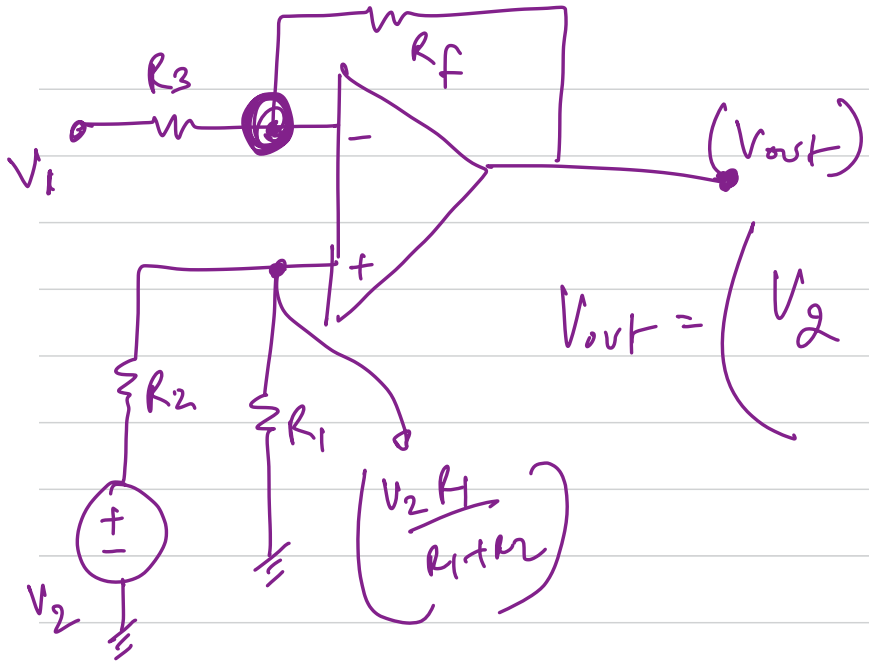
$$(V_- = V_2)$$

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

loop gain $\left(\frac{R_f}{R_1} \gg 1 \right)$ loop 이득

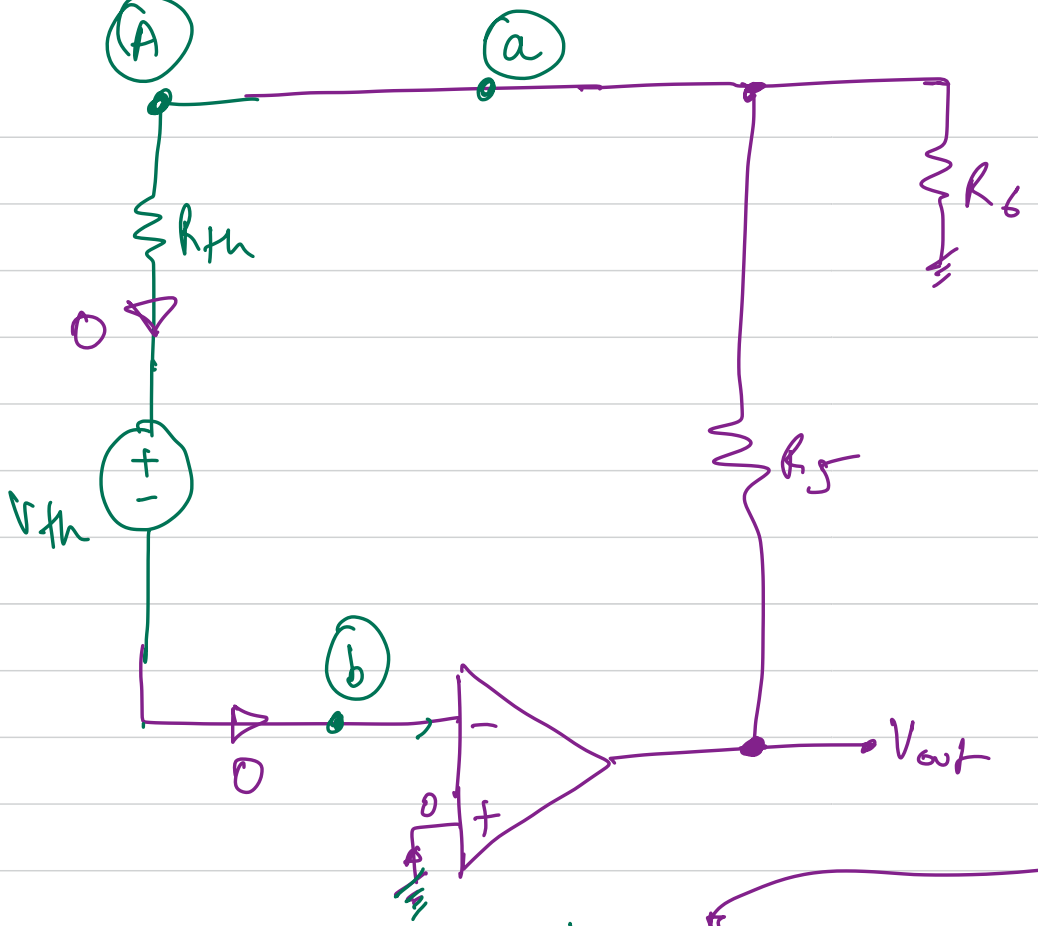
$$V_{out} = \left\{ \left(\frac{R_f}{R_1} + 1 \right) V_2 - \frac{R_f}{R_1} V_{in} \right\}$$

→ V_{out} = $\left(\frac{R_f}{R_1} \right)(V_2 - V_1)$



$$V_{out} = \left(V_2 \left(1 + \frac{R_f}{R_3} \right) \left(\frac{R_1}{R_1+R_2} \right) - \frac{R_f}{R_3} V_1 \right)$$

Q1

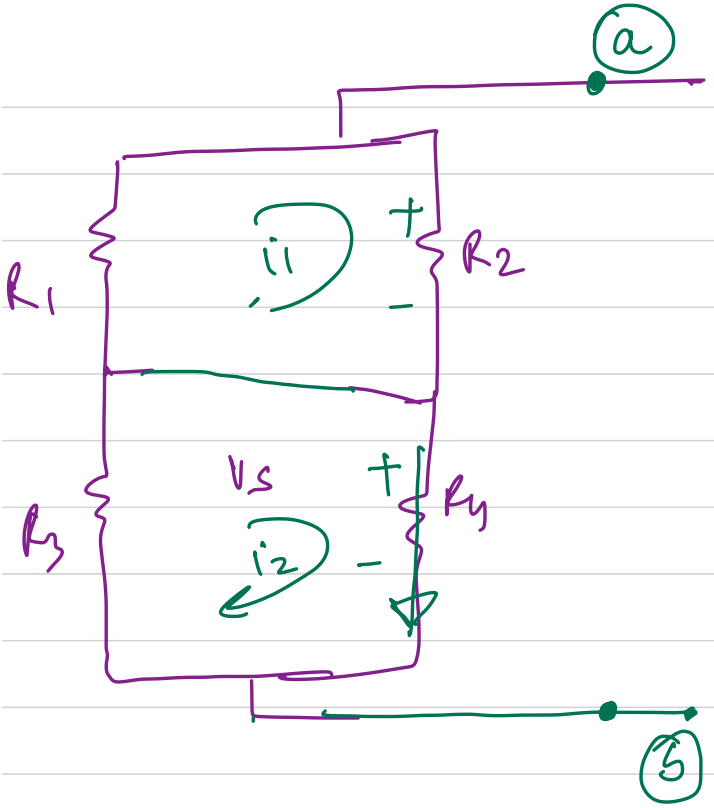


$\left(\frac{V_{out}}{V_S}\right) = ?$

$\left(V_A = V_{th}\right)$

$V_{out} = \left(1 + \frac{R_5}{R_6}\right) V_{th}$

$$V_A\left(\frac{1}{R_{th}} + \frac{1}{R_5} + \frac{1}{R_6}\right) - \frac{V_{th}}{R_{th}} - \frac{V_{out}}{R_5} = 0.$$



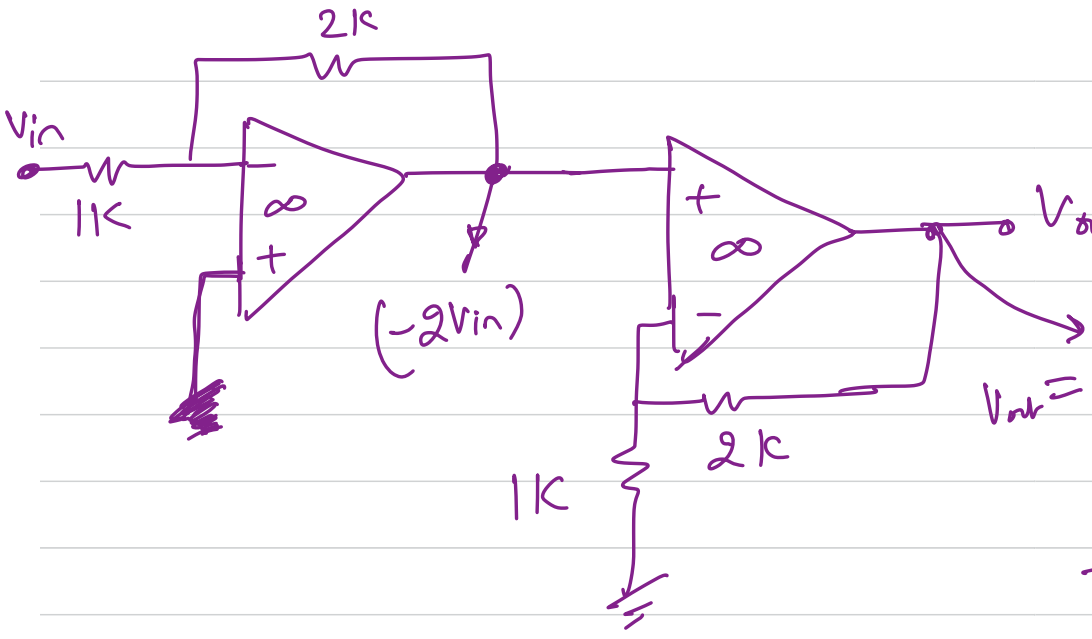
$$i_1 = V_s/(R_1+R_2) \qquad i_2 = \frac{-V_s}{(R_3+R_4)}$$

$$V_{ab} = i_1 R_2 + i_2 R_4$$

$$V_{oc} = V_{th} = \left(\frac{R_2}{(R_1+R_2)} V_s - \frac{R_4}{R_3+R_4} V_s\right)$$

$$R_{th} = (R_1 \| R_2 + R_3 \| R_4)$$

$$V_{out} = \left(1 + \frac{R_5}{R_6}\right)\left[\frac{R_2}{R_1+R_2} V_s - \frac{R_4}{R_3+R_4} V_s\right]$$

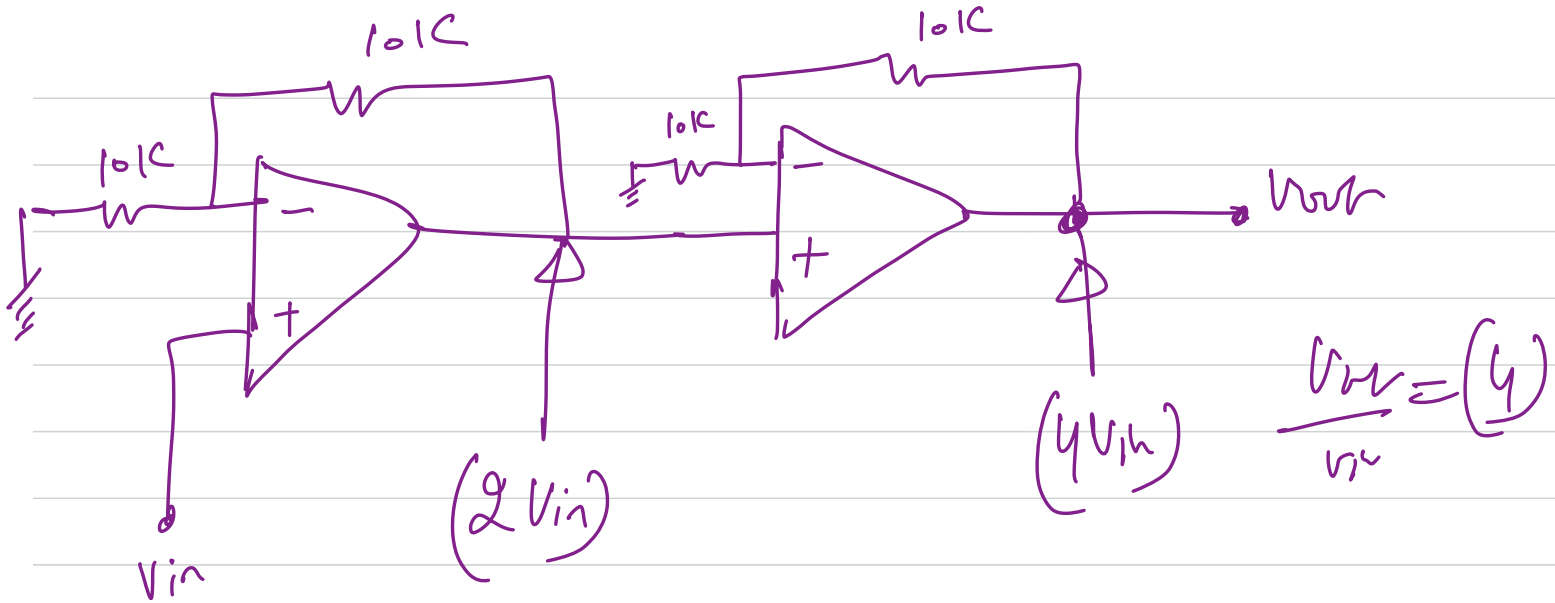


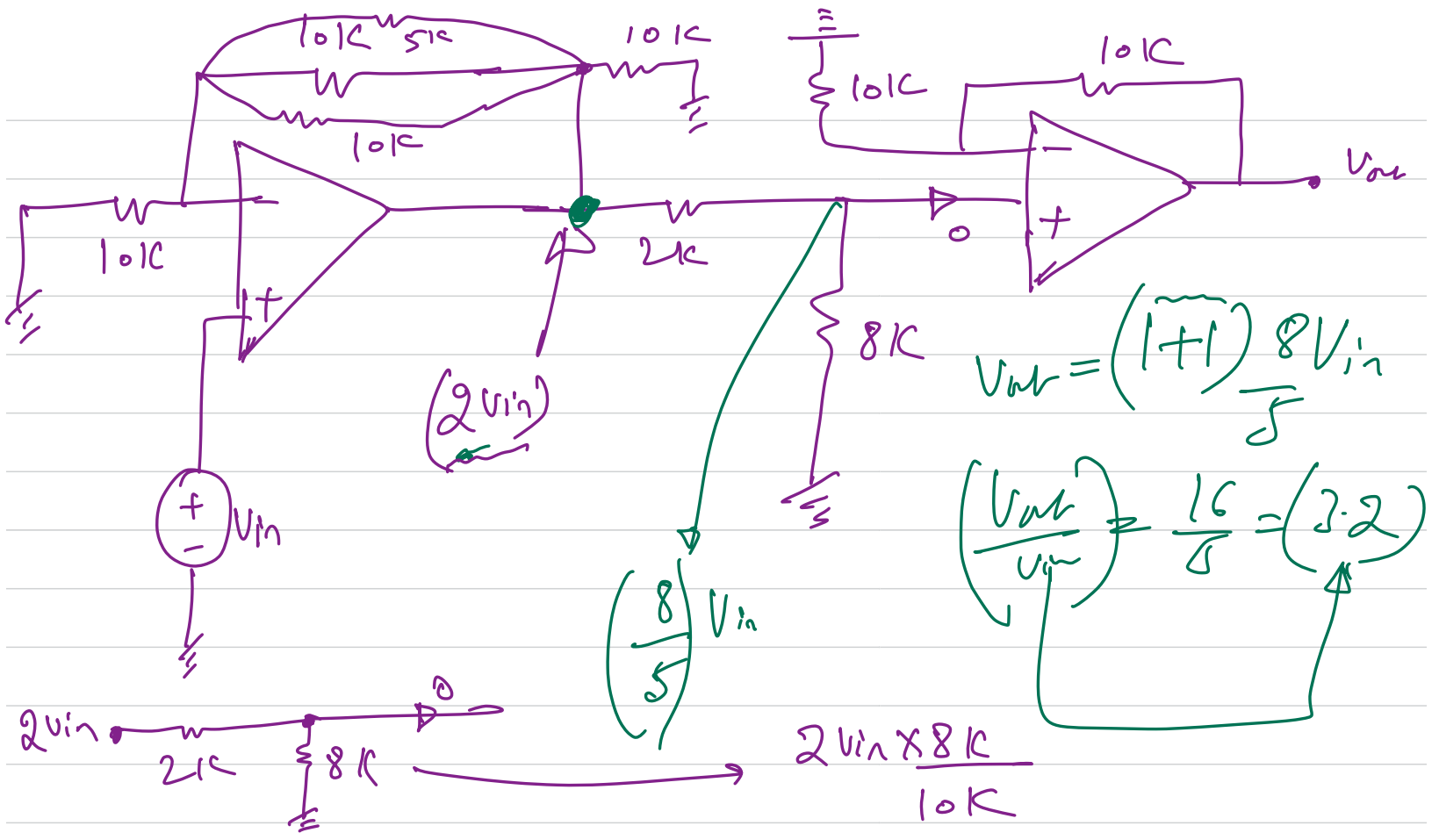
$$V_{out} = \left(1 + \frac{R_f}{R_1}\right) V_{in} = \left(1 + \frac{2}{1}\right)(-2V_{in})$$

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

$$= -6$$

"Cascading" of the amplifier


10kΩ
10kΩ
10kΩ
10kΩ
−
+
−
+
V_{out}
V_{in}
$(2V_{in})$
$(4V_{in})$
$\frac{V_{out}}{V_{in}} = (4)$


10K
5K
10K
10K
10K
10K
10K
2K
8K
V_{in}
$2V_{in}$
$\frac{8}{5}V_{in}$
$V_{out} = \left(1+\frac{1}{5}\right) 8V_{in}$
$\frac{V_{out}}{V_{in}} = \frac{16}{5} = 3.2$
$2V_{in}$
2K
8K
$\frac{2V_{in} \times 8K}{10K}$