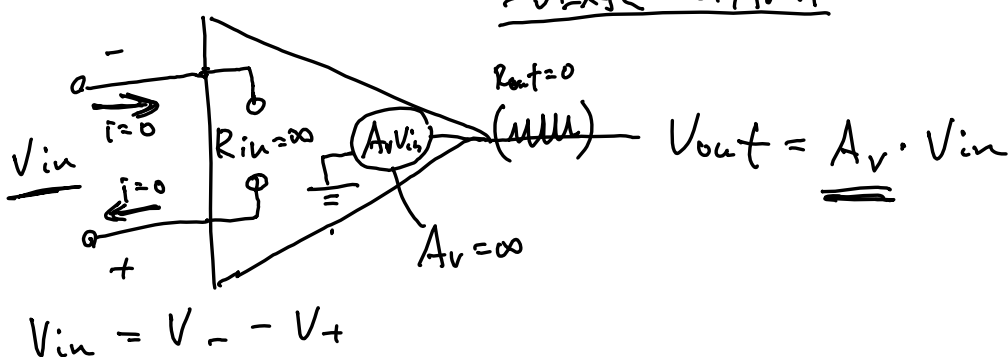


HW #7:

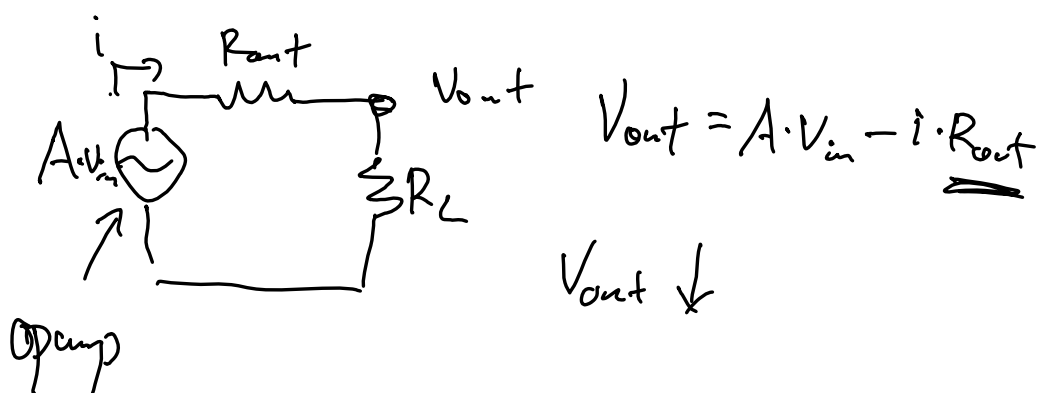
IDEAL OPAMP



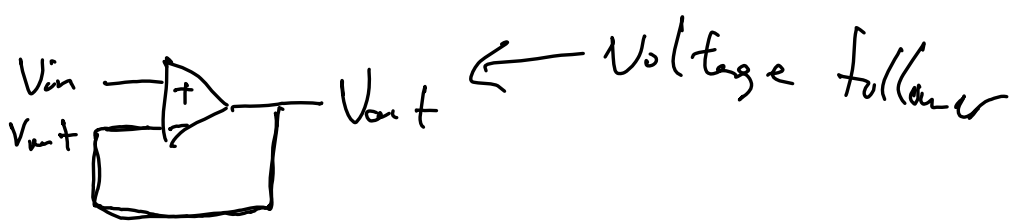
1. a) $R_{in} = \infty$

$$i_{in} = \frac{V_{in}}{R_{in}} \rightarrow 0$$

b) If $R_{out} > 0$, V_{out} ?



c) $A_{cl} < A_{ol}$ w/ negative feedback



$$V_{out} = A_{ol}(V_{in} - V_{out}) = A_{ol}V_{in} - A_{ol}V_{out}$$

$$V_{out}(A_{ol} + 1) = A_{ol} \cdot V_{in}$$

$$V_{out} = V_{in} \cdot \frac{A_{ol}}{A_{ol} + 1} \approx 1 \text{ if } A_{ol} \gg 1$$



$$V_{out} = V_{in} \cdot \frac{A_{ol}}{(1 - A_{ol})} < 0 \text{ doesn't make sense.}$$

w/ positive feedback, $A_{cl} \neq A_{ol}$

d) If $R_{in} < \infty$, I_{in} ?

$$I_{in} = \frac{V_{in}}{R_{in}} > 0$$

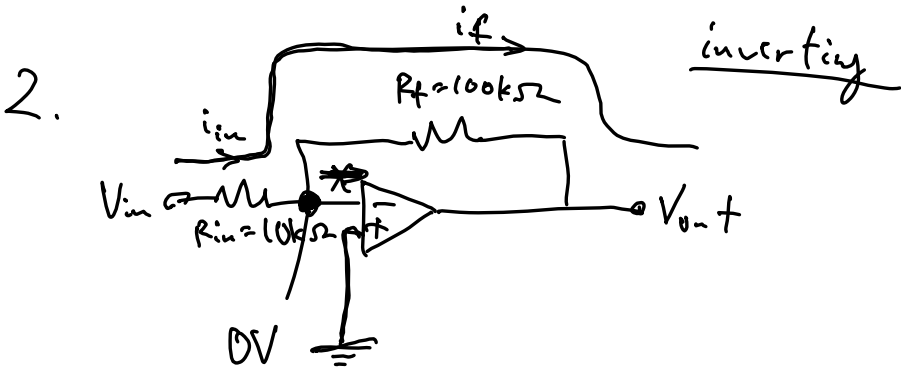
e) If $A_{ol} \rightarrow 0.99 A_{ol}$, i_{out} ?

$$A_{cl} \neq A_{ol}$$

$$V_{out} \propto A_{cl}$$

$$i_{out} = \frac{V_{out}}{R} \propto A_{cl}$$

nothing happens to i_{out}



a) $A_{cl} = -\frac{R_f}{R_{in}} = -\frac{100k\Omega}{10k\Omega} = -10$

b) $\phi = 180^\circ$

c) find i_f if $V_{in} = 1.2V$

Assumption 1: no current through opamp inputs

$\hookrightarrow i_f = i_{in}$

Assumption 2: virtual ground

$V_- = V_+ = 0V$

$i_f = i_{in} = \frac{V_{in}}{R_{in}} = \frac{1.2V}{10k\Omega} = 120\mu A$

d) find i_{in} if $V_{in} = 0.3V$

$i_{in} = \frac{V_{in}}{R_{in}} = \frac{0.3V}{10k\Omega} = 30\mu A$

e) for $A_{cl} = 20$, find R_f & R_{in}

$A_{cl} = -\frac{R_f}{R_{in}} = -20$

R_f must be $20 \times R_{in}$

ex) $R_{in} = 5k\Omega \rightarrow R_f = 100k\Omega$

f) find i_f if $A_{cl} = 20$

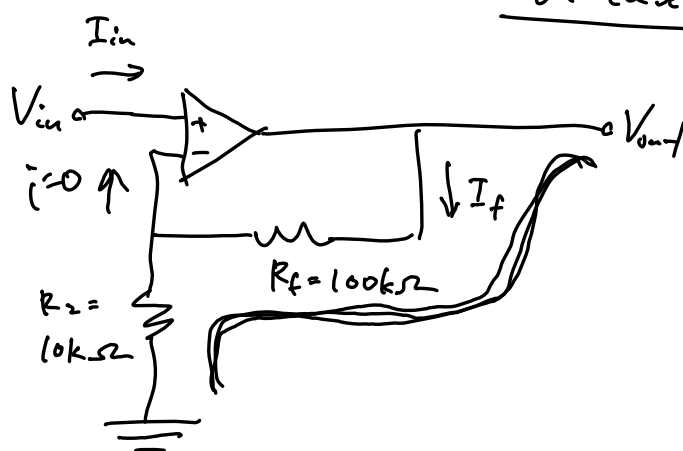
$i_f = \frac{V_{in}}{R_{in}} \times A_{cl}$

i_f stays the same unless R_{in} changes

g) if $R_f = R_{in}$, $A_{cl} = -1$

inverting buffer (no isolation)

3.

non-inverting

$$c) A_{cl} = 1 + \frac{R_f}{R_2} = 1 + \frac{100k\Omega}{10k\Omega} = 11$$

$$b) \phi = 0$$

$$c) \text{ If } V_{in} = 1.5V, \text{ find } i_f$$

$$V_{out} = i \cdot R_{total} = i \cdot (R_f + R_2)$$

$$i = i_f = \frac{V_{out}}{R_f + R_2} = \frac{A_{cl} \cdot V_{in}}{R_f + R_2}$$

$$= \frac{11 \cdot 1.5V}{100k\Omega + 10k\Omega} = 150\mu A$$

$$d) \text{ If } A_{cl} = 25, \text{ find } R_f \text{ \& } R_2$$

$$A_{cl} = 1 + \frac{R_f}{R_2} \rightarrow \frac{R_f}{R_2} = A_{cl} - 1 = 24$$

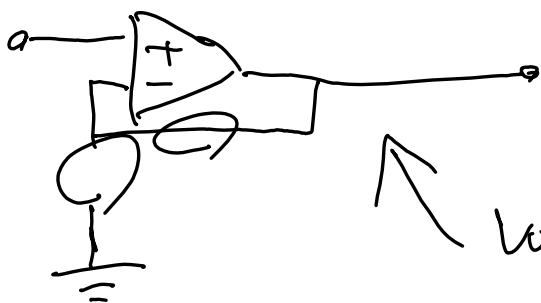
$$\text{ex) } R_2 = 10k\Omega \rightarrow R_f = 240k\Omega$$

$$e) \text{ If } A_{cl} = 25,$$

$$i_f = \frac{V_{out}}{R_f + R_2} \propto \frac{1}{R_f + R_2}$$

i_f stays the same unless R_f/R_2 changes.

$$f) \text{ If } R_f = 0, R_2 = \infty \rightarrow A_{cl} = 1 + \frac{R_f}{R_2}$$



$$= 1$$

↑ voltage follower