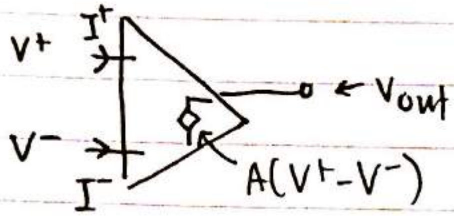
03/10

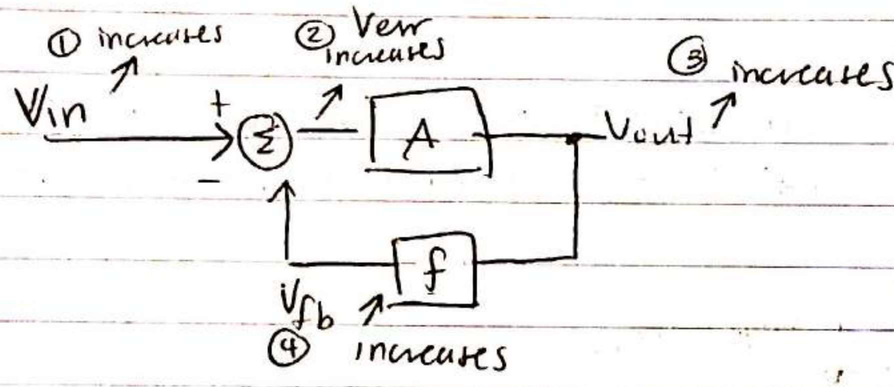
Op-Amps

Golden Rules Review:



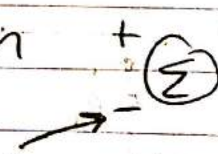
① $I^+ = I^- = 0$.

② $V^+ = V^-$ (1) why?
(2) when?

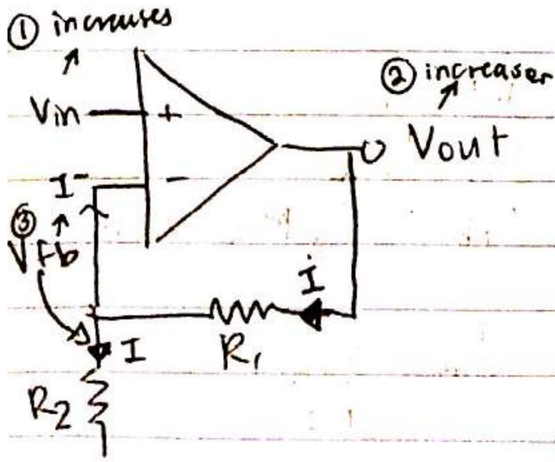


but in the next cycle, Verr decreases. ($V_{fb} + V_{err} = V_{in}$)
Vout decreases

pos/neg. feedback dependent on



neg if −
pos if +

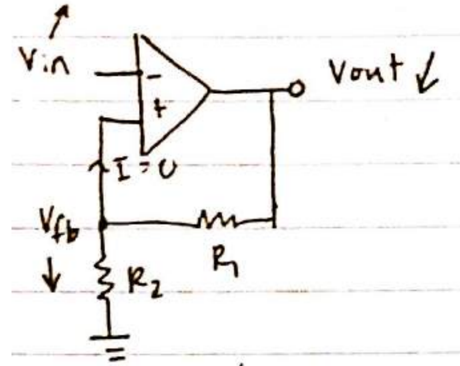


V_{fb} increases − because $I^- = 0$.

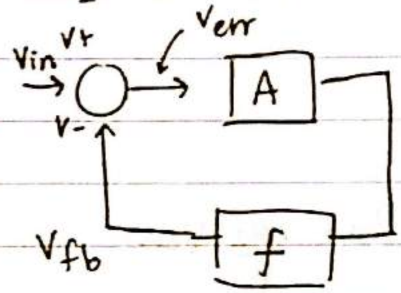
$V_{fb} = \frac{R_2}{R_1 + R_2} \cdot V_{out}$, $f = \frac{R_2}{R_1 + R_2}$

Since $V^- \uparrow$, $V_{out} \downarrow$.

what would happen if :



pos. feedback - slams to 0.



$V_{err} = V^+ - V^-$.

$V_{out} = A \cdot V_{err}$

$V^- = V_{fb} = f \cdot V_{out}$

$V_{out} = A \ (V^+ - f V_{out})$

$\rightarrow V_{out} = \dfrac{A \cdot V^+}{1 + Af}$

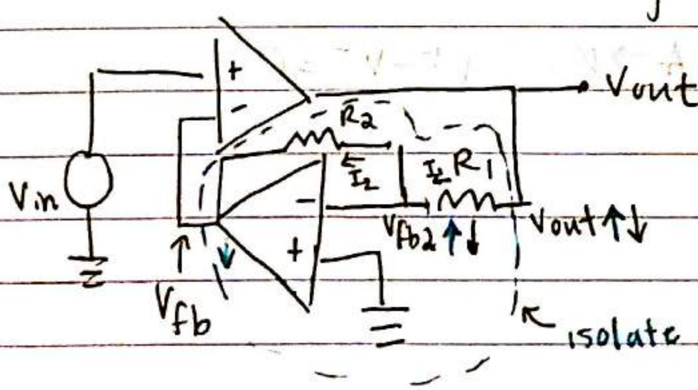
$V_{fb} = f \cdot \dfrac{A V^+}{1 + Af} = V^-$.

If $A \rightarrow \infty$, $V_{fb} \rightarrow V^+$.

So $V_{fb} = V^- = V^+$.

Also,

$V_{out} = \dfrac{V^+}{f}$.

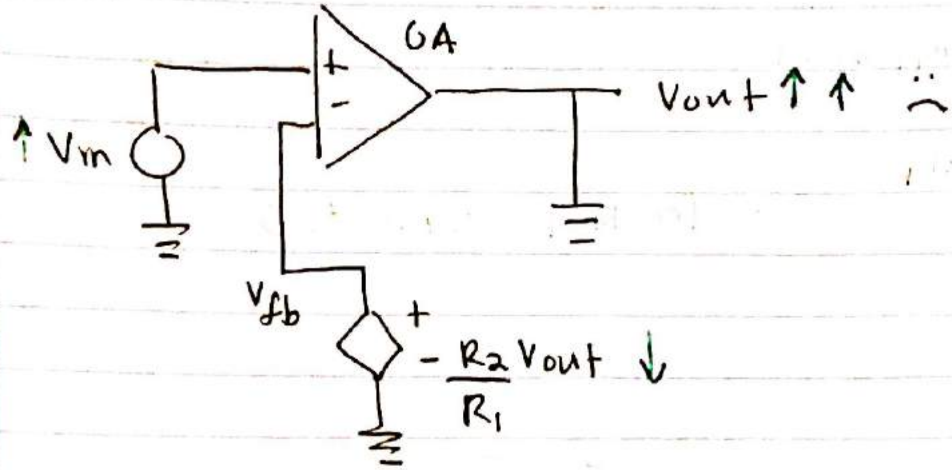


$V_{fb2} = 0 \quad (V^+ = 0)$

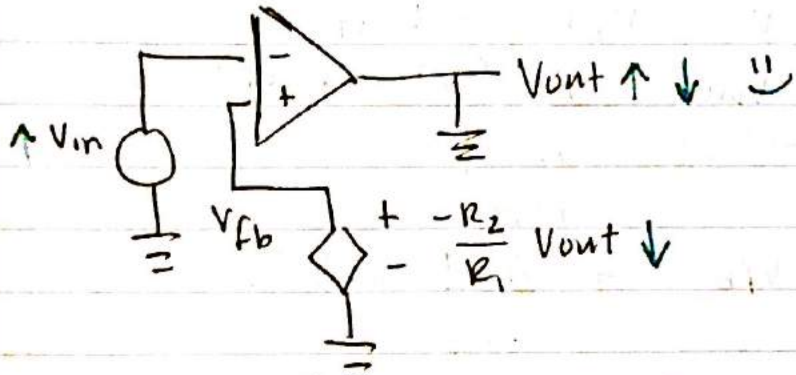
$I_1 = \dfrac{V_{out}}{R_1}$

$\dfrac{-R_2}{R_1} \cdot V_{out}$ because $V_{fb2} = 0$.

So $\boxed{V_{fb} = \dfrac{-R_2}{R_1} V_{out}.}$



So we switch +/-.

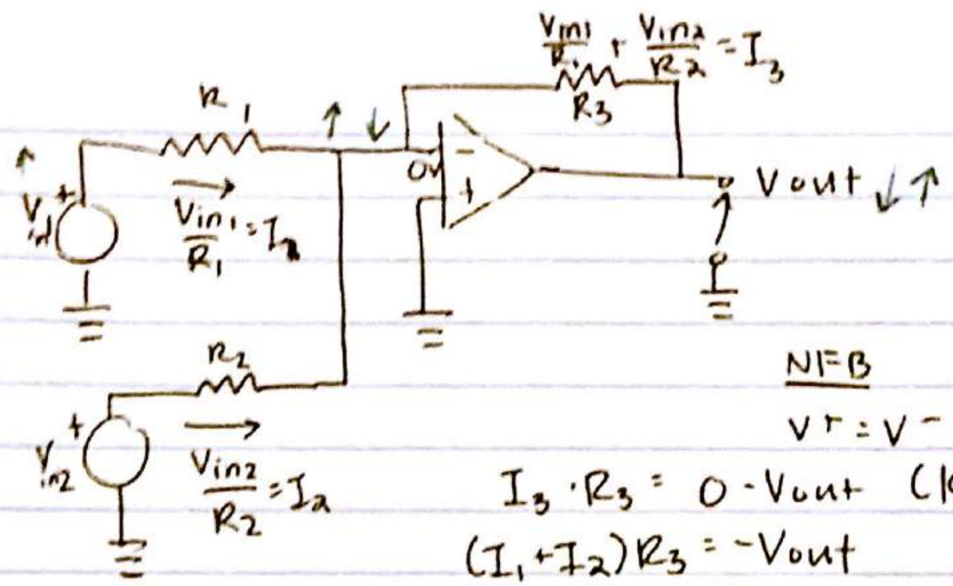


$$V_{in} = \frac{-R_2}{R_1} V_{out}$$

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

$$V^- = \frac{fA}{1+Af} V^+$$

$$V^+ - V^- = \frac{1}{1+Af} V^+ \qquad \text{If } A \to \infty, \quad V^+ - V^- = 0.$$



NFB

$V^+ = V^-$

$I_3 \cdot R_3 = 0 - V_{out}$ (KVL)

$(I_1 + I_2) R_3 = -V_{out}$

$$V_{out} = -\left(\frac{V_{in1}}{R_1} + \frac{V_{in2}}{R_2}\right) R_3$$

$$V_{out} = -V_{in1}\left(\frac{R_3}{R_1}\right) - V_{in2}\left(\frac{R_3}{R_2}\right)$$