

EECS 16A, Lecture 8, Mod2 ^①

• Capacitive Touchscreen

→ scaling up

→ drift

(→ current source)

• Opamps = "Operational Amplifiers"

→ Feedback

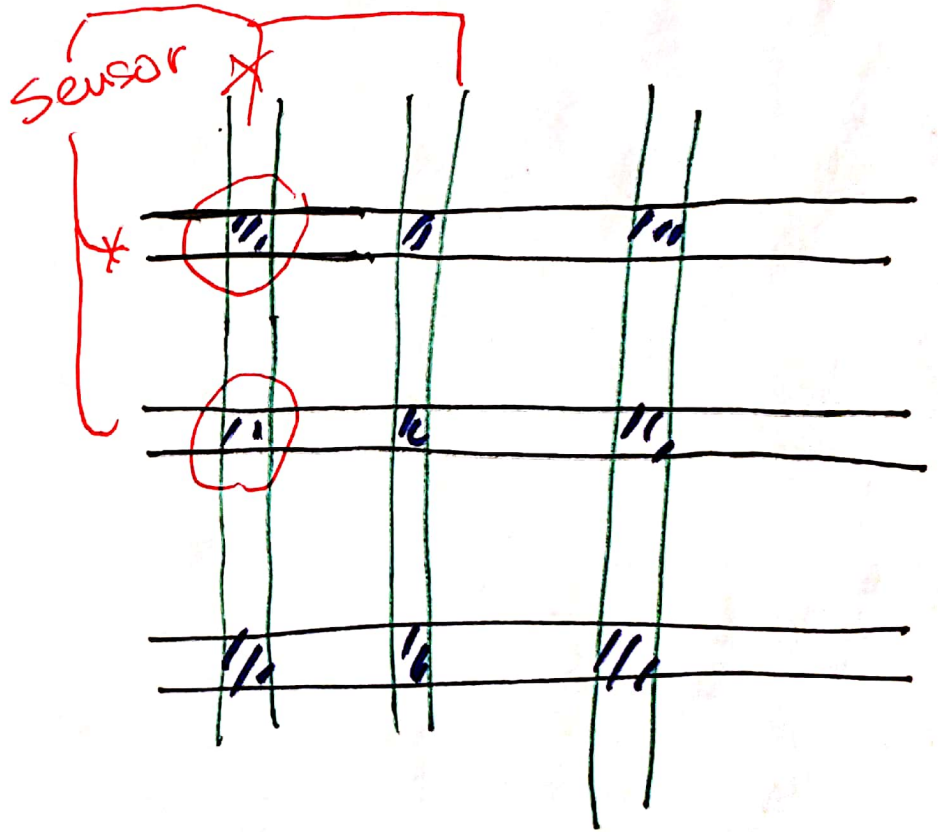
→ Ideal Opamps

→ Buffer

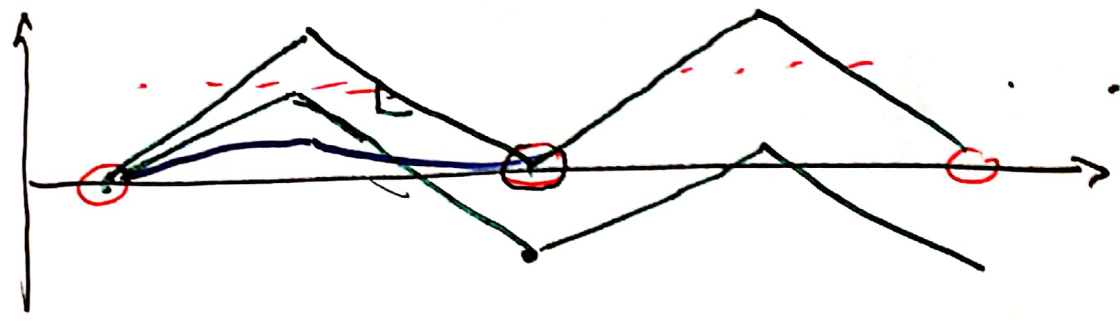
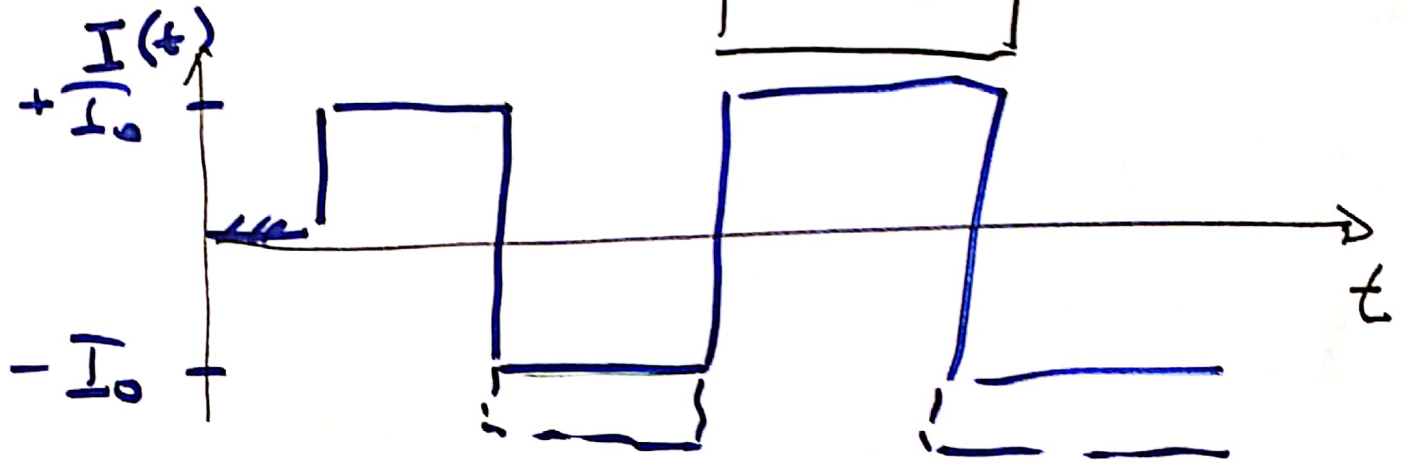
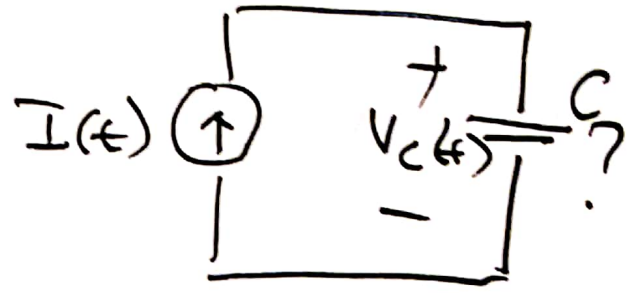
Touch: soaking up



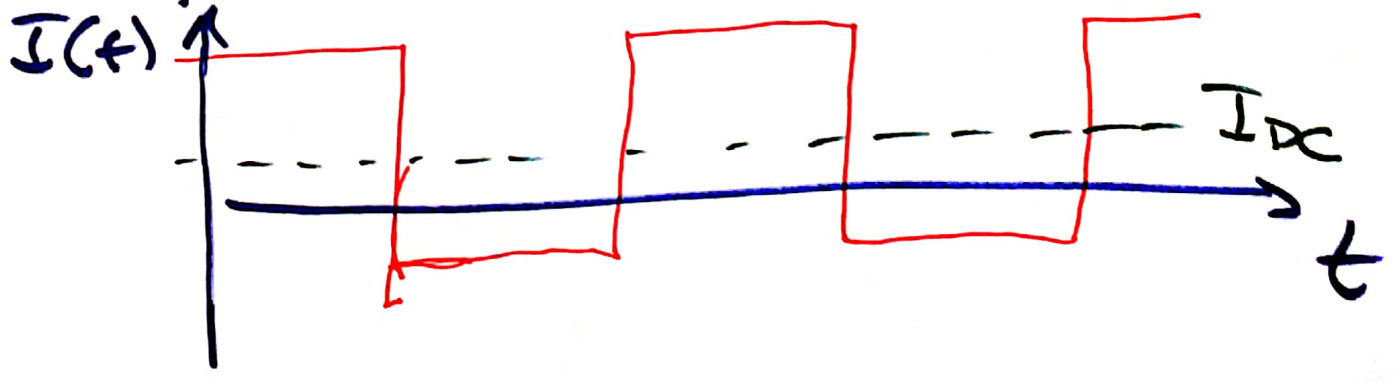
Button



Drift:

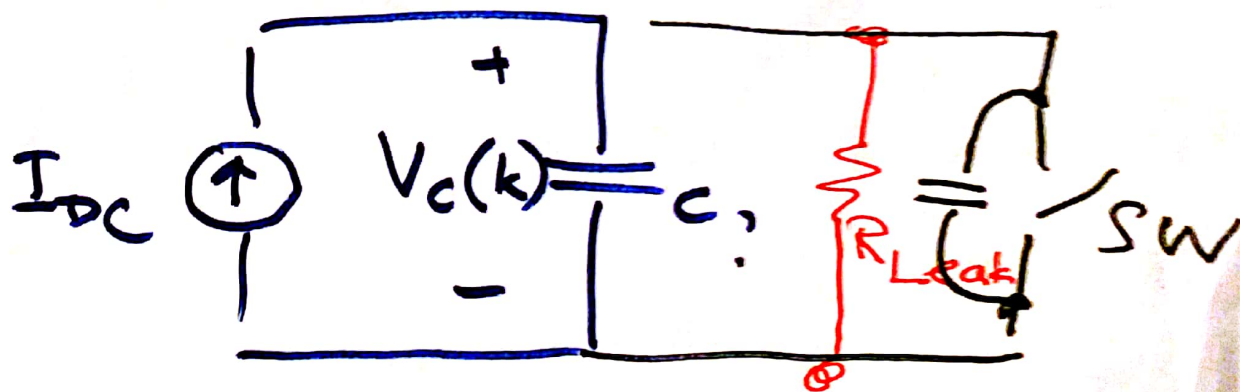
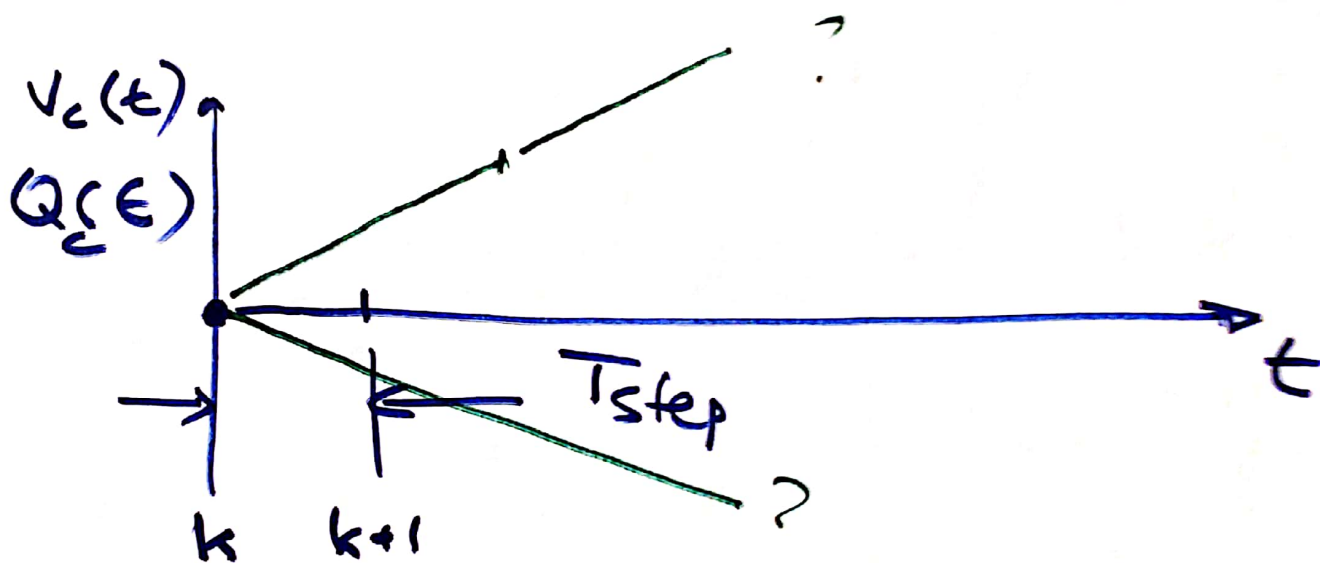
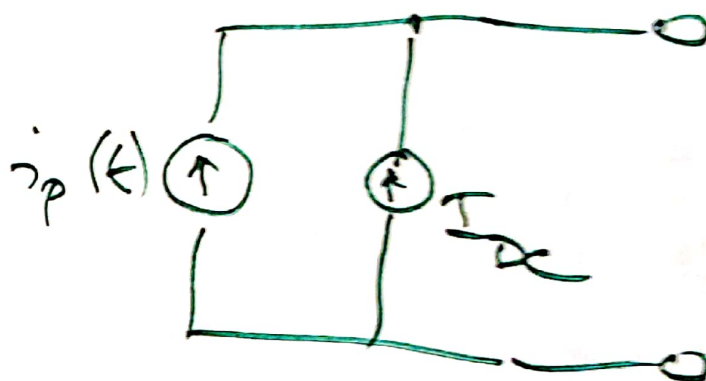
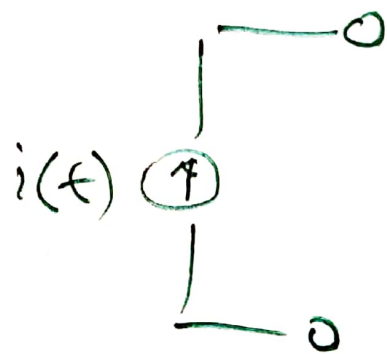


Imperfect SQ. wave:



$$I(t) = I_{SQ, \text{perfect}}(t) + I_{DC}$$

(4)



$$x(k+1) = x(k) + u(k) \quad (5)$$

$$t_1 = k \cdot T_{\text{step}}$$

$$t_2 = (k+1) \cdot T_{\text{step}} \dots$$

$$Q_c(k)$$



$$Q_c(k+1) = Q_c(k)$$

$$+ I_{DC} \cdot T_{\text{step}}$$

$$- \frac{V_c(k)}{R_{\text{leak}}} \cdot T_{\text{step}}$$

$$Q_c \rightarrow V_c$$

$$Q = C \cdot V$$

$$\div C?$$

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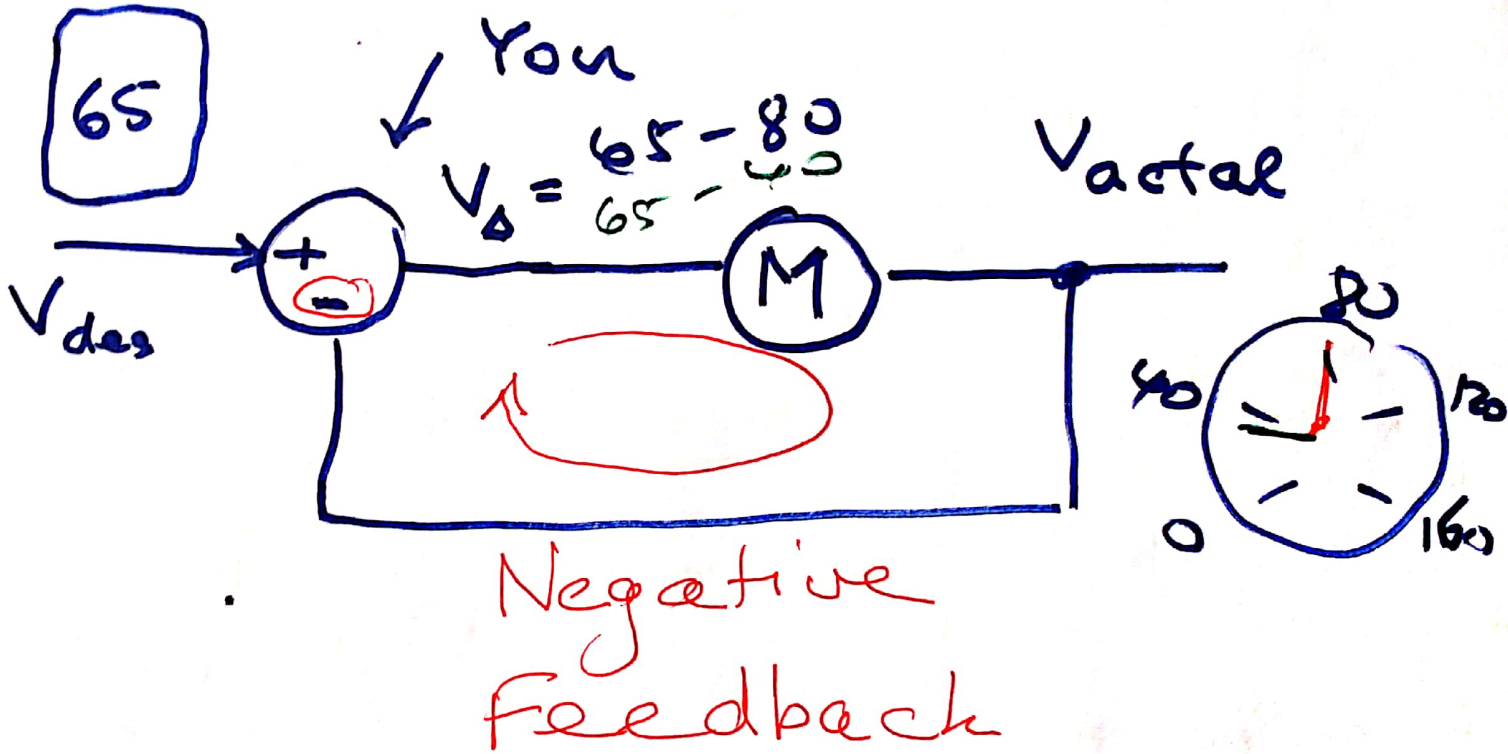
$$V_c(k+1) = V_c(k)$$

$$+ \left(\underbrace{I_{DC}}_{\Delta q_{DC}} - \underbrace{\frac{V_c(k)}{R_{Leak}}}_{-\Delta q_R} \right) \cdot \frac{T_{step}}{C}$$

Op Amps

⑦

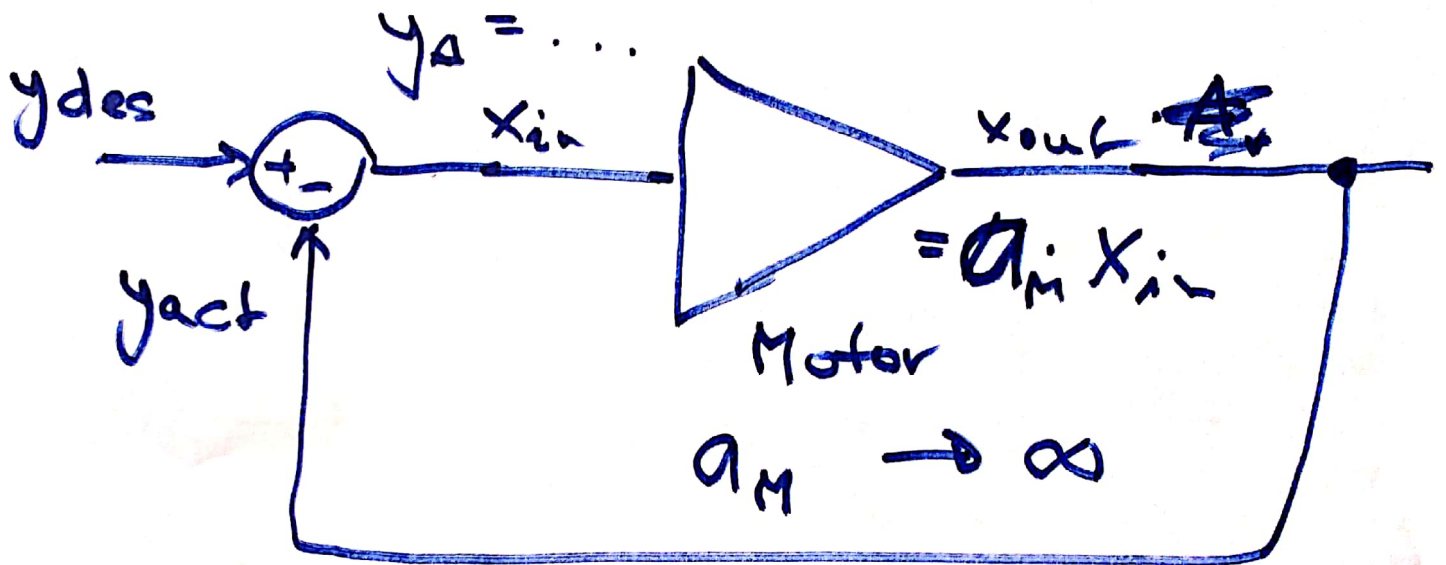
Feedback



- Motor \rightarrow ideally infinitely powerful

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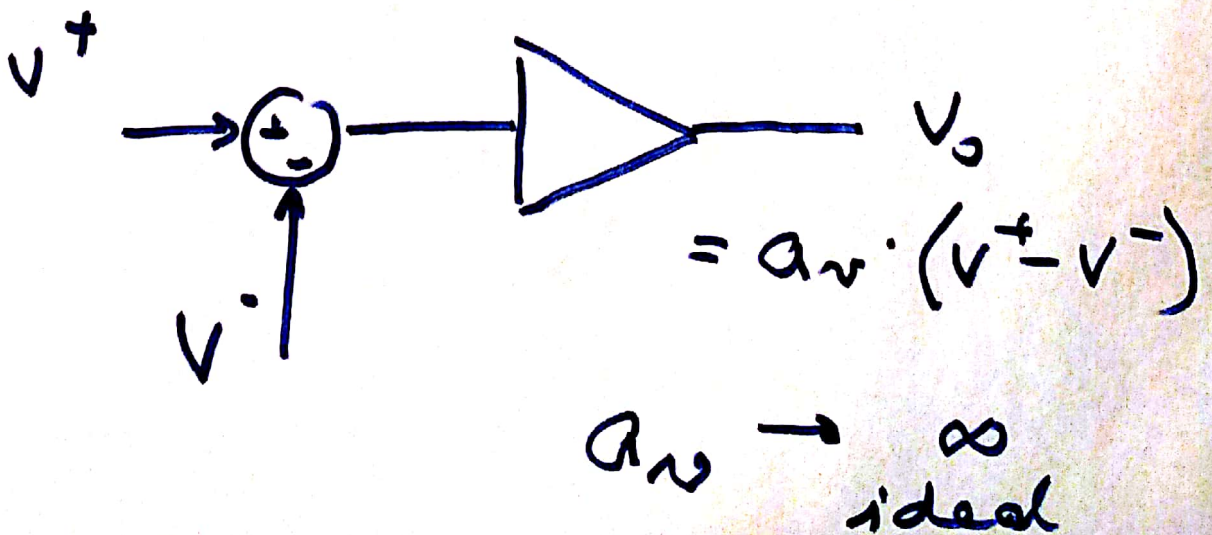
Model:



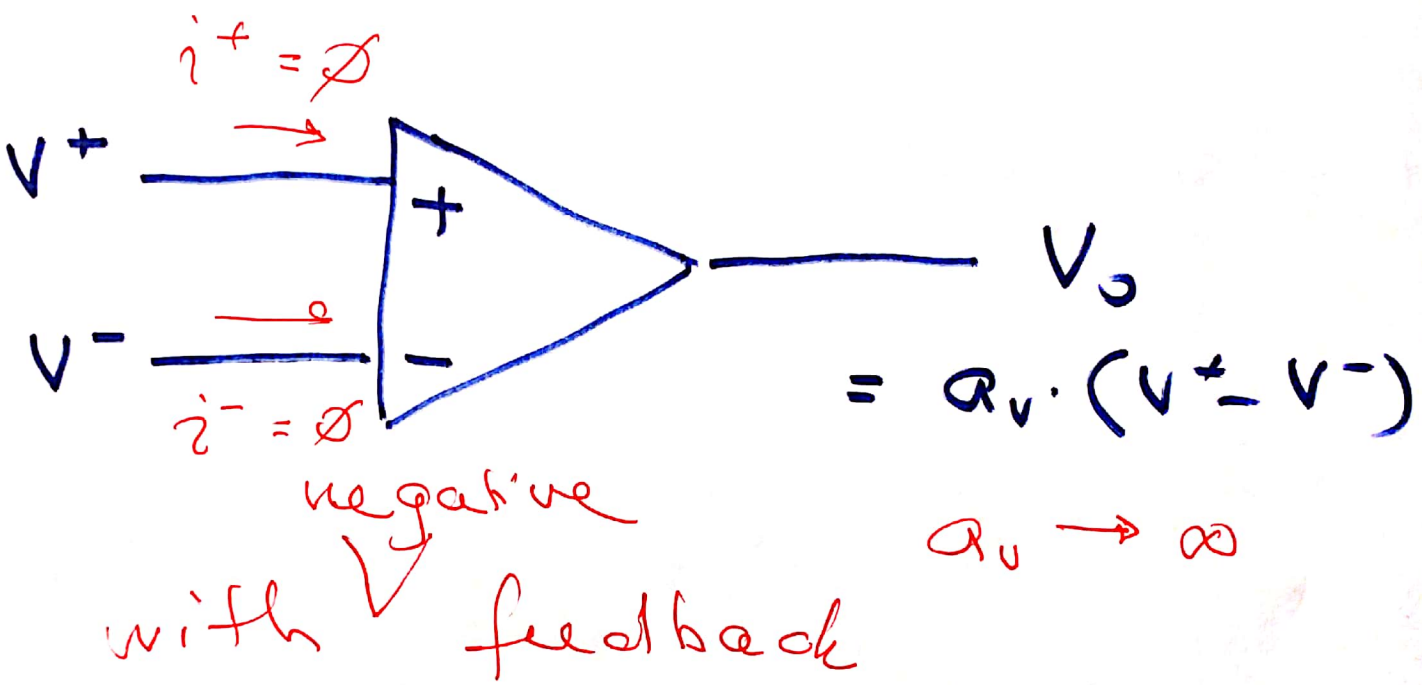
$$y_0 = y_{des} - y_{act} = \emptyset$$

For $a_M \rightarrow \infty$

Opamp



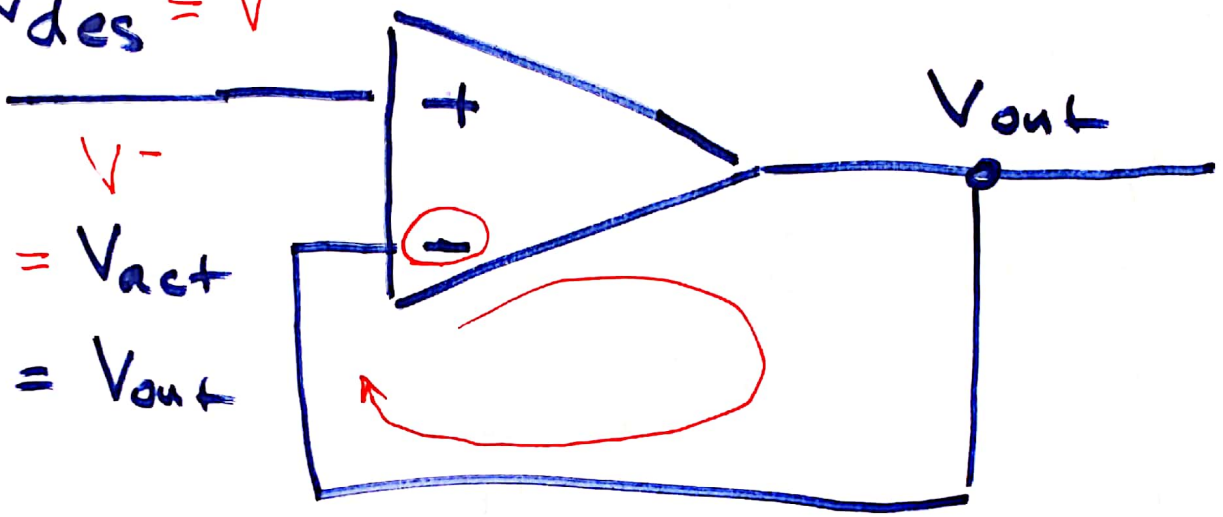
Symbol:



$V^+ = V^-$

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$$V_{in} = V_{des} = V^+$$



$$V^- = V_{act} = V_{out}$$

$$V^+ = V_{in} = V^- = V_{out}$$

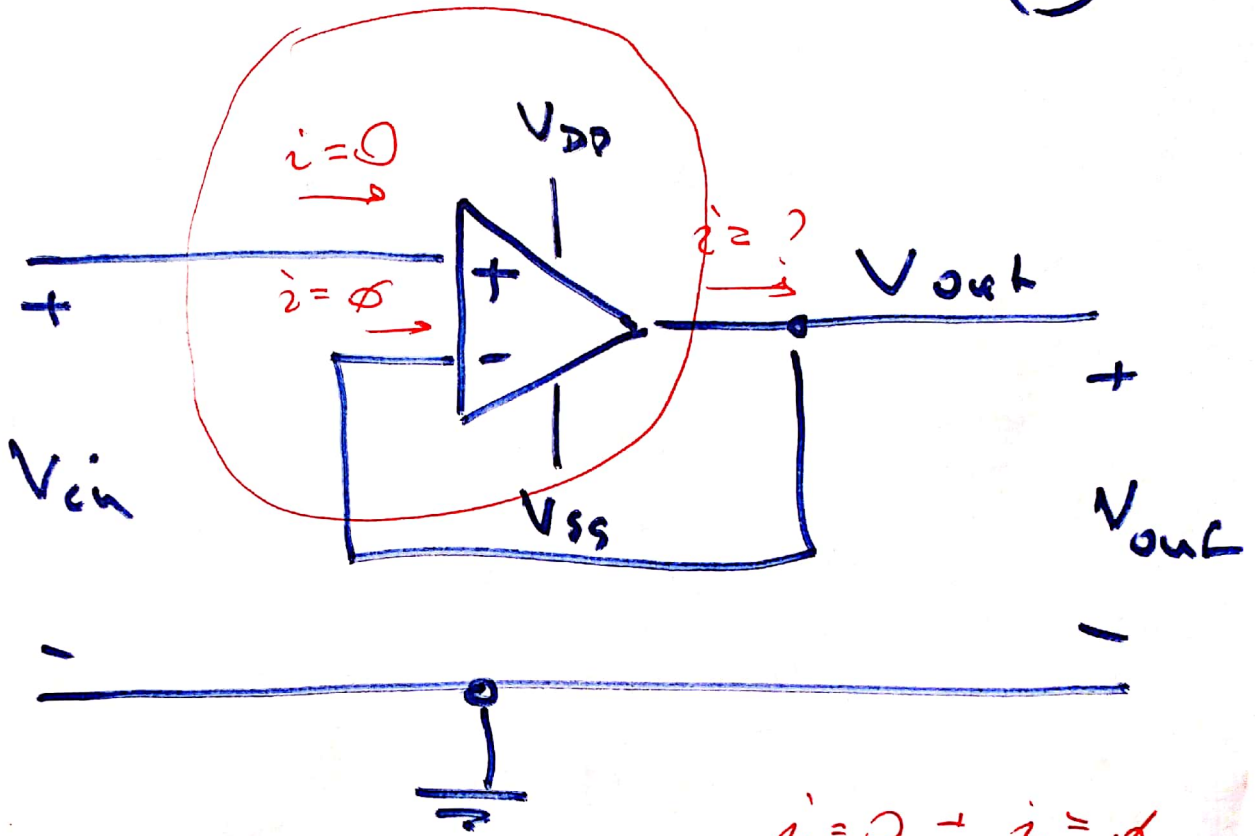
$$V_{out} = V_{in}$$

$$V_{out} = a_v \cdot (V^+ - V^-)$$

$$= a_v \cdot (V_{in} - V_{out})$$

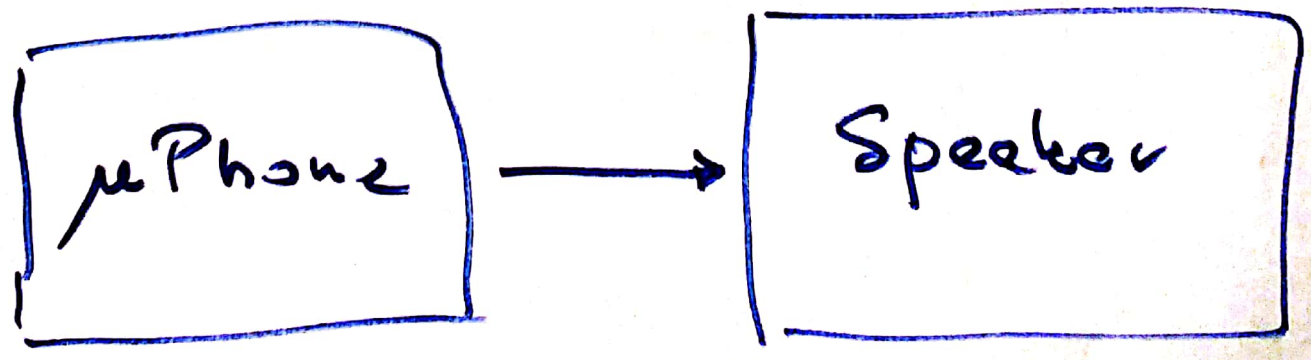
$$\Rightarrow V_{out} = \frac{a_v}{a_v + 1} \cdot V_{in} \Bigg|_{a_v \rightarrow \infty} = V_{in}$$

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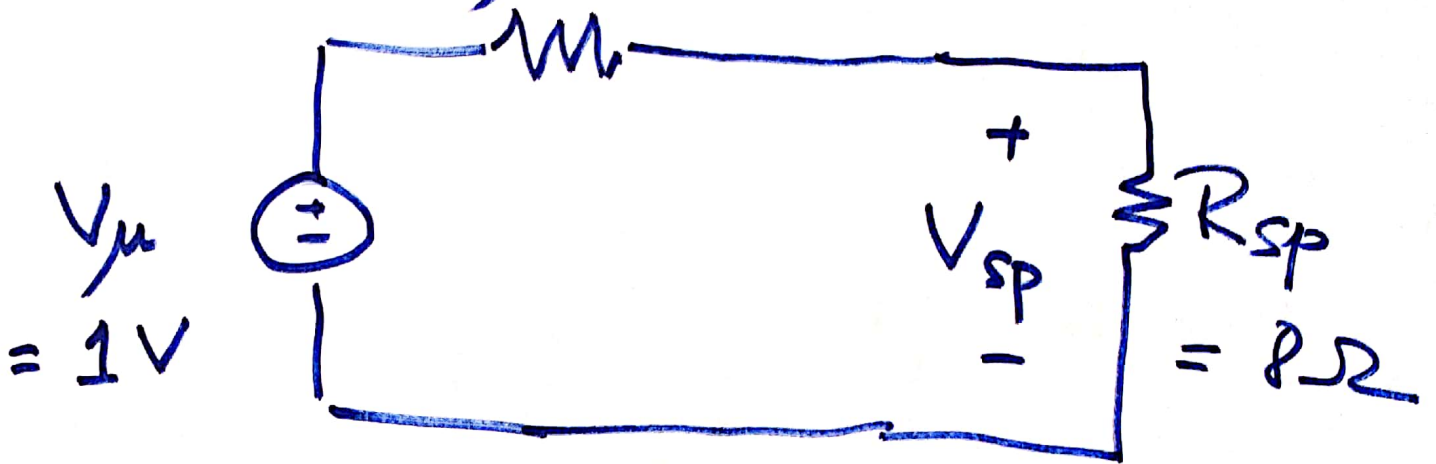
$$V_{out} = V_{in}$$

$$i = 0 + i = \phi$$
$$= i = ?$$
$$0 + 0 = ?$$



$$R_{\mu} = 1\text{M}\Omega = 10^6 \Omega$$

(12)



$$V_{sp} = V_{\mu} \cdot \frac{8\Omega}{10^6 \Omega + 8\Omega}$$

$$\approx 8\mu\text{V}$$

$$P_{sp} = \frac{V_{sp}^2}{R_{sp}} = \frac{64 \cdot 10^{-12}}{8}$$

$$= 8 \cdot 10^{-12} \text{ W}$$

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