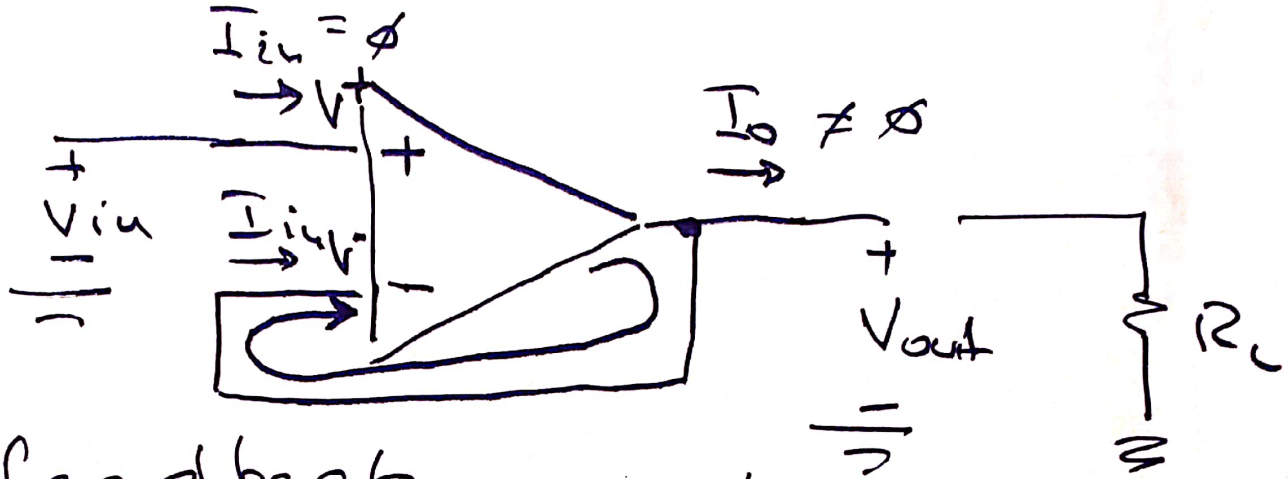
EECS 16A, Lecture 9, Mod 2

Opamps

- Recap
- Gain stages (basic configurations)
- NVA with opamps
- Current source
- Examples

Recap

$V_{out} = V_{in}$ => Buffer



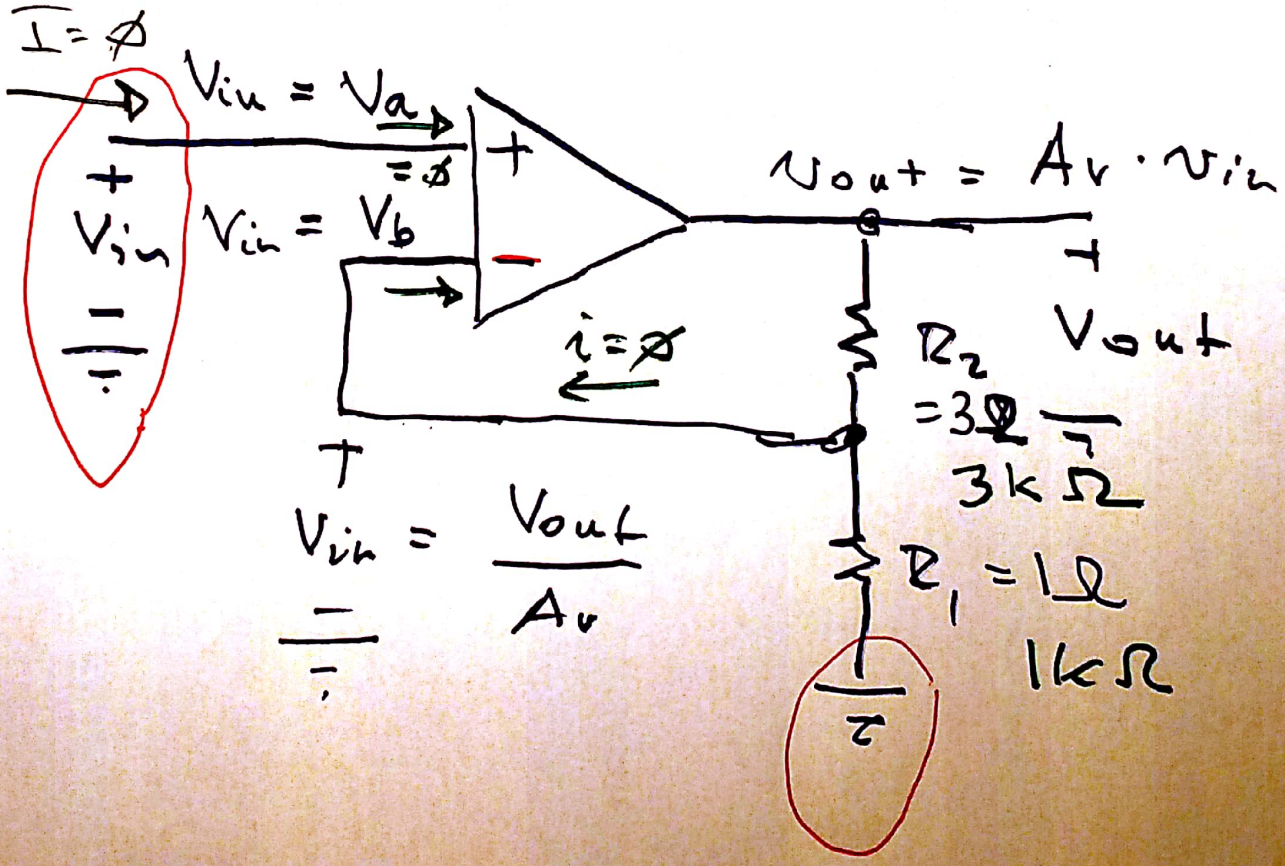
- feedback, negative
- ideal opamp:
  - infinite "open loop" gain
  - $I_{in} = 0$
  - "no supply"

$$V^+ = V^-$$

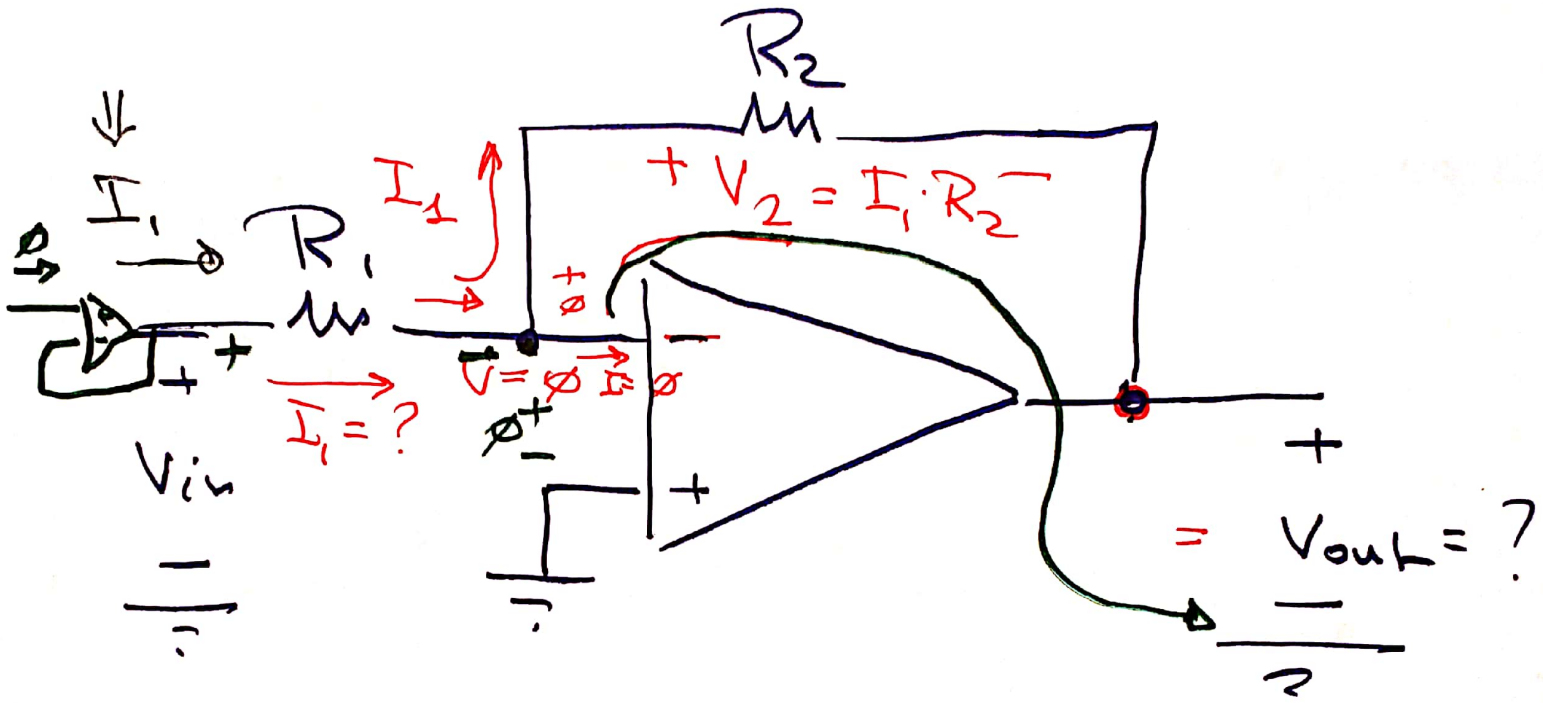
Gain, Non-inverting

$$\frac{V_{out}}{V_{in}} = A_v = \text{e.g. } 4$$

↑ closed loop gain



Inverting Gain stage



$$V_{out} = f(V_{in}, R_1, R_2)$$

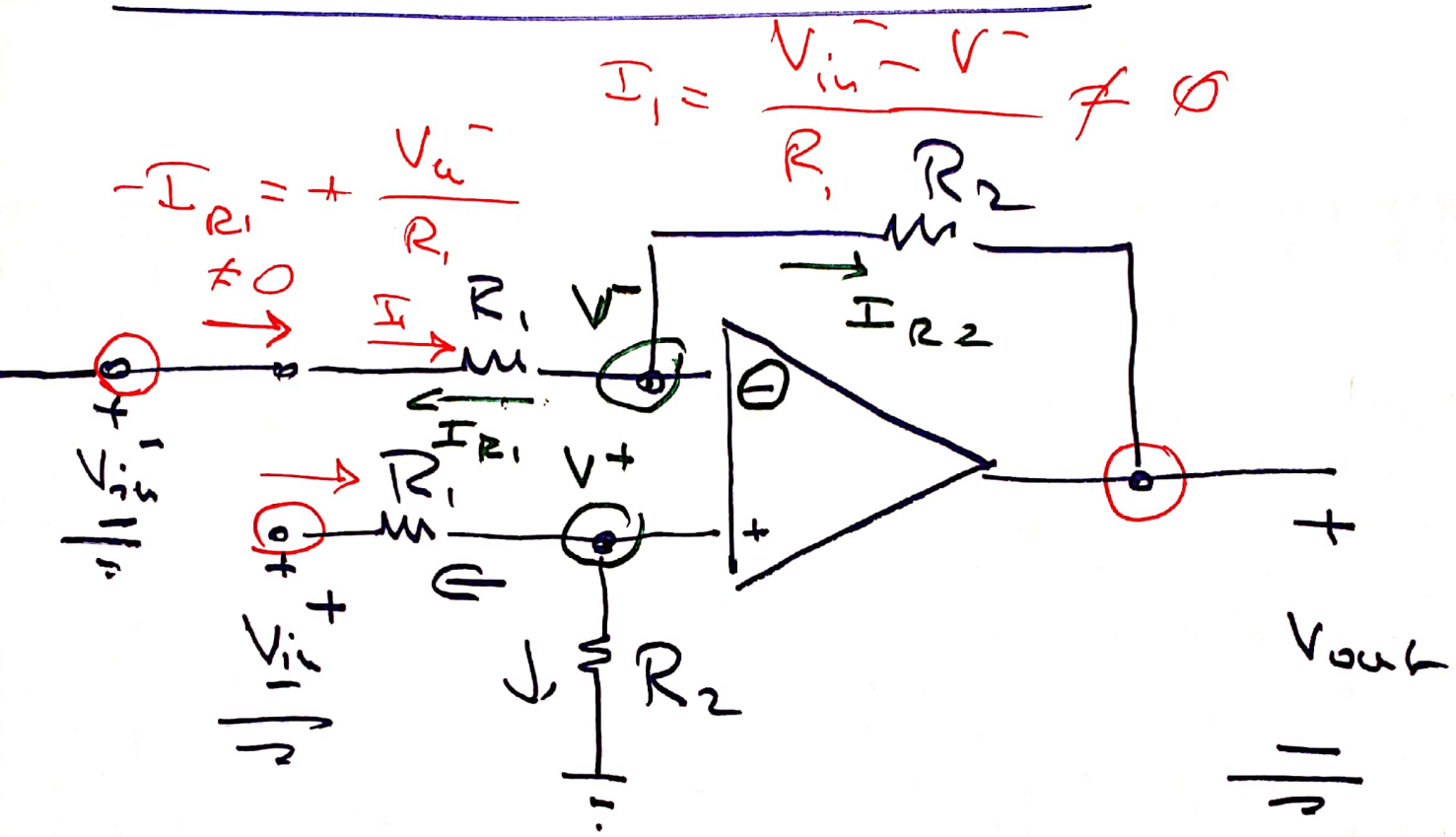
$$I_1 = \frac{V_{in}}{R_1}$$

KVL: $V_2 + V_{out} = \emptyset$

$$V_{out} = -V_2 = -I_1 \cdot R_2$$

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

NVA for Op Amps



- no eq for V_{out}

- $V^+ = V^-$

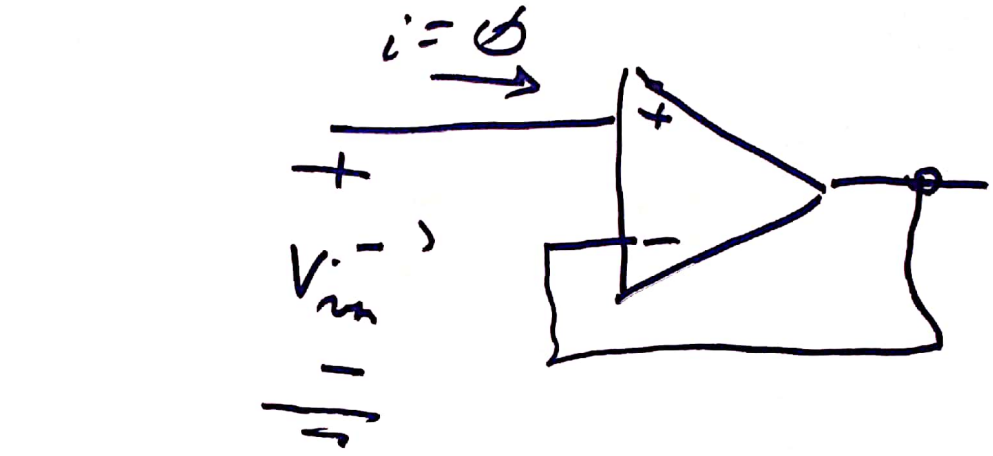
$\underline{I}$ (V^-) $\quad I_{R1} + I_{R2} = 0$

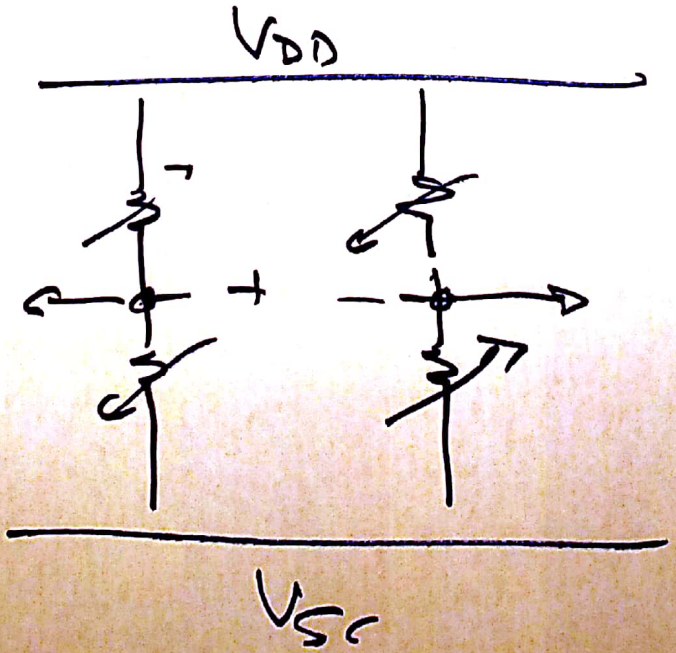
$$\Downarrow$$

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

$\underline{I}$ $\quad \frac{V^+ - V_{in}^+}{R_1} + \frac{V^+}{R_2} = 0$

5a



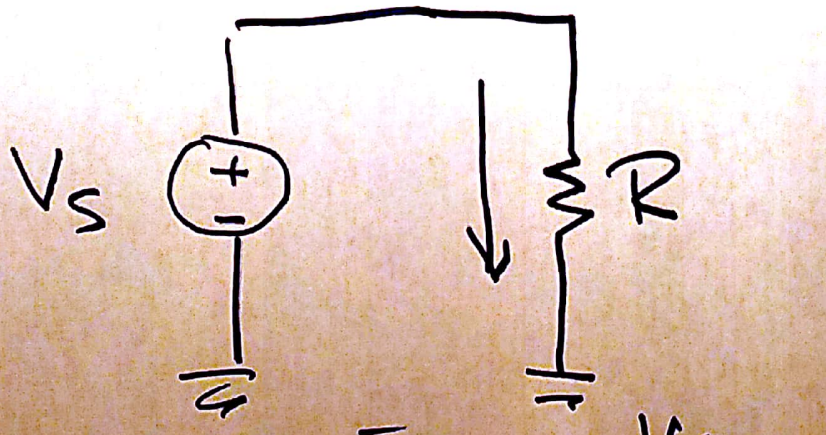


If $V^+ = V^-$

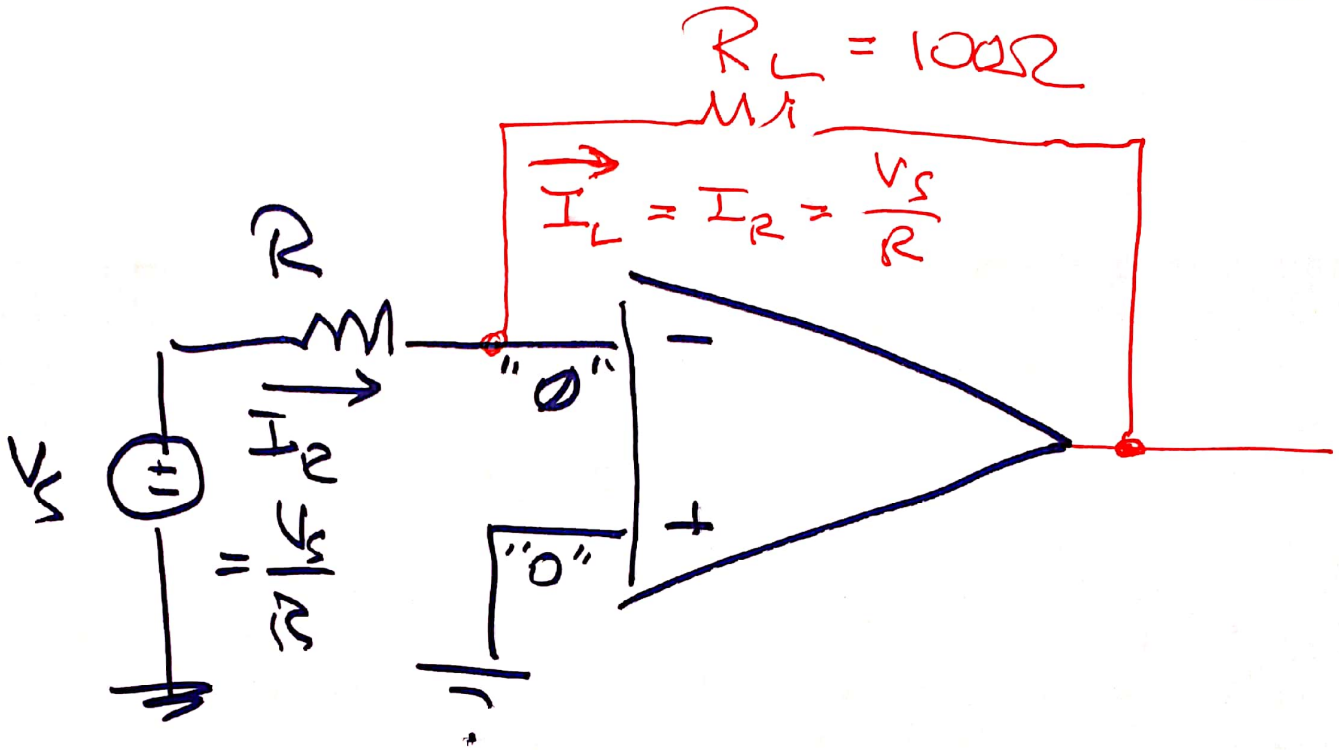
$\therefore$

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

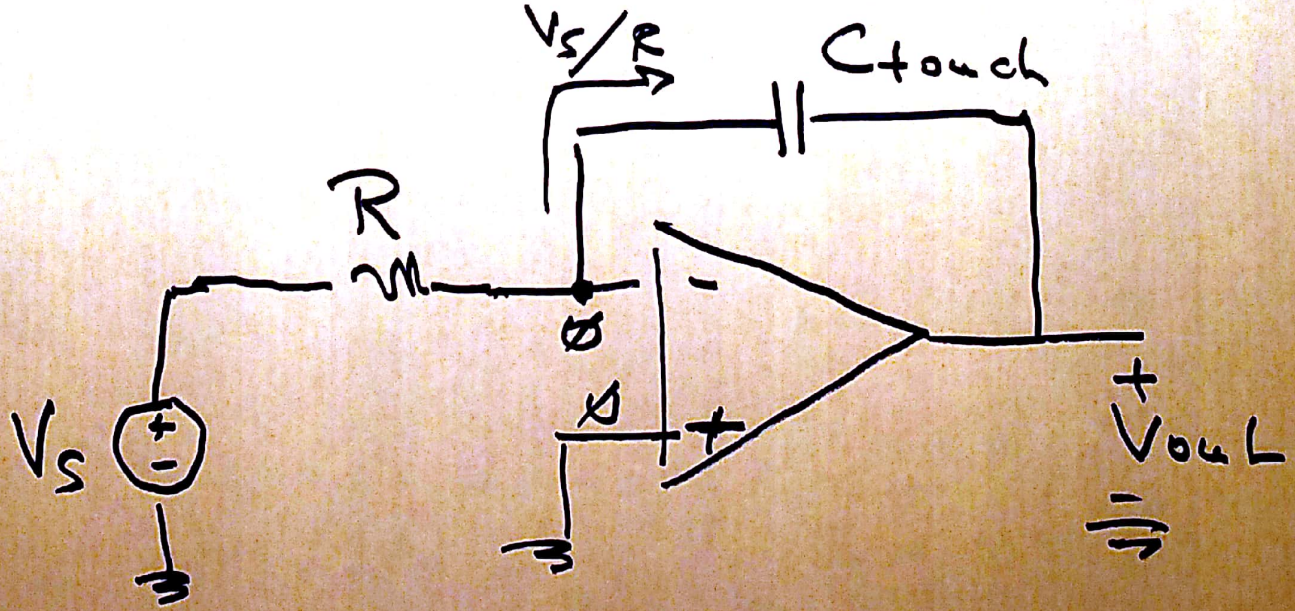
Current Source



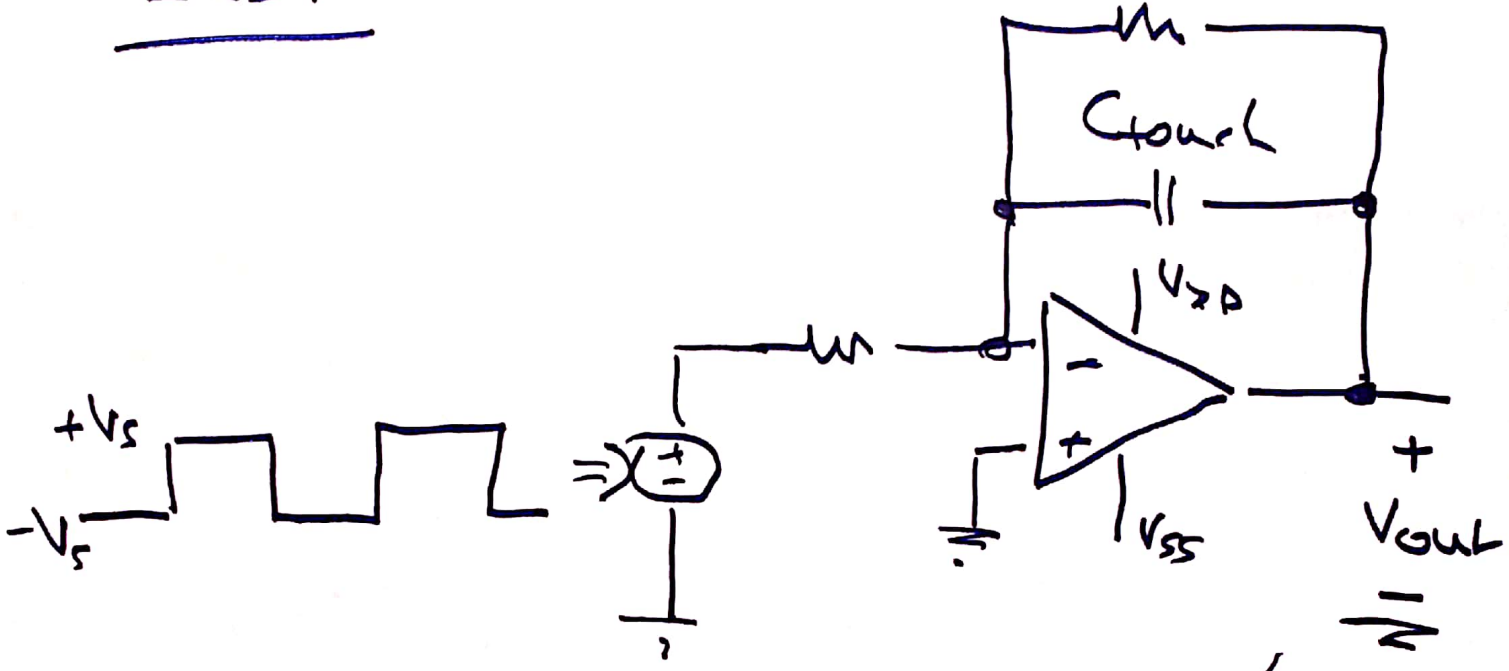
$$I_R = \frac{V_S}{R}$$

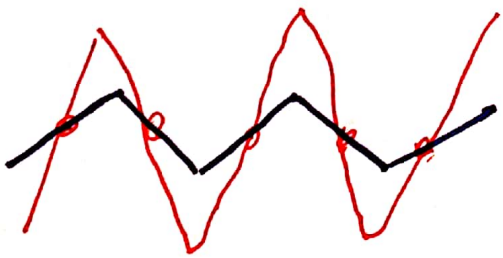


Touch Sensor



Lab:





Oscilloscope