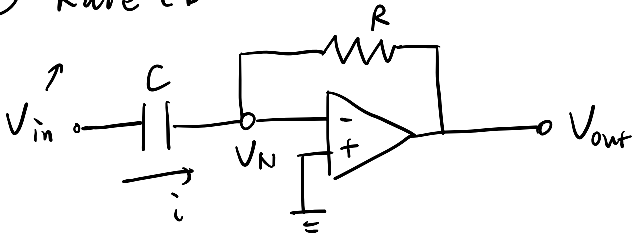
Theoretical Basis

① Rate (Derivative) Circuit



1) For the capacitor,

$$(V_{in} - V_N) \cdot C = q$$

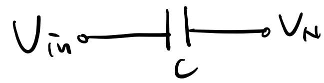
Take the derivative of both sides,

$$(\dot{V}_{in} - \dot{V}_N) \cdot C = \dot{q}$$

Since $V_N \equiv 0 \Rightarrow \dot{V}_N = 0$

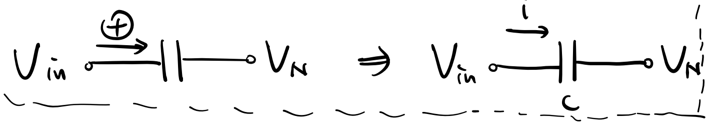
$$\Rightarrow \quad \dot{V}_{in} C = \dot{q} = i$$

To determine the direction of i



Suppose $\dot{V}_{in} > 0$, which means that the value of V_{in} is increasing.

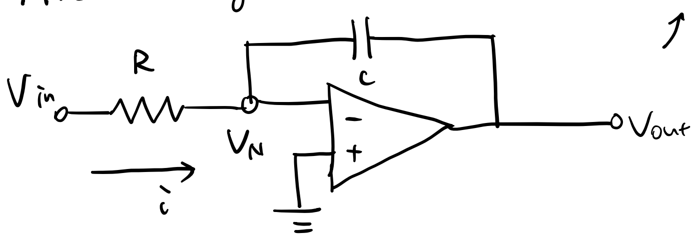
⇒ There will be more positive charges on the right-side of the capacitor.



2) For the operational amplifier,

$$\frac{V_N - V_{out}}{R} = i \Rightarrow V_{out} = -iR = -(RC)\dot{V}_{in}$$

② Area (Integral) Circuit



★ Key points:

the topology position of resistor and capacitor in the rate/area circuits.

① For the resistor R on the input terminal,

$$\frac{V_{in} - V_N}{R} = i \xrightarrow{V_N = 0} i = \frac{V_{in}}{R}$$

② For the operational amplifier,

$$(V_N - V_{out}) \cdot C = q \xrightarrow{V_N = 0} q = -V_{out} \cdot C$$

Take the derivatives of both sides,

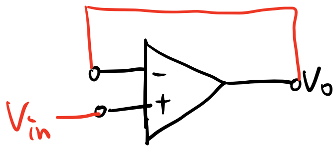
$$\dot{q} = -C \cdot \dot{V}_{out} \Longrightarrow \dot{V}_{out} = -\frac{1}{C} \cdot \frac{V_{in}}{R} = -\frac{1}{RC} \cdot V_{in}$$

Take the integrals of both sides,

$$V_{out} = -\frac{1}{RC} \int V_{in}\, dt$$

Experiment 5 : Performing Rate and Area Operations

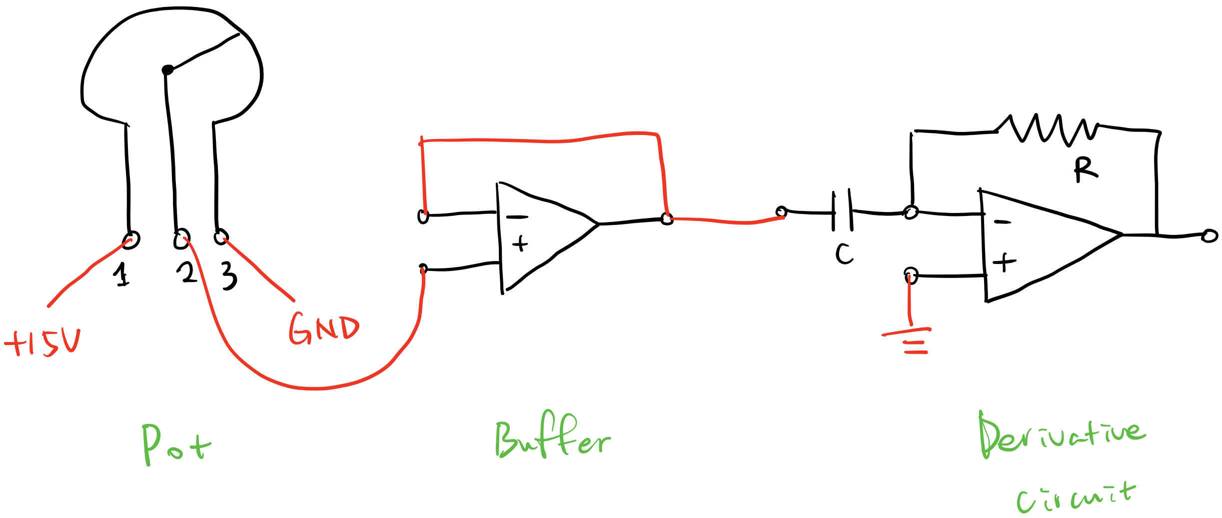
Review. Buffer circuit



$V_o = V_{in}$

Hint.

① Connection diagram of the derivative circuit



Safety. A resistor can be connected before the pot.

Deliverables :

① Pics of derivative and integral circuits

② Group Number + Name