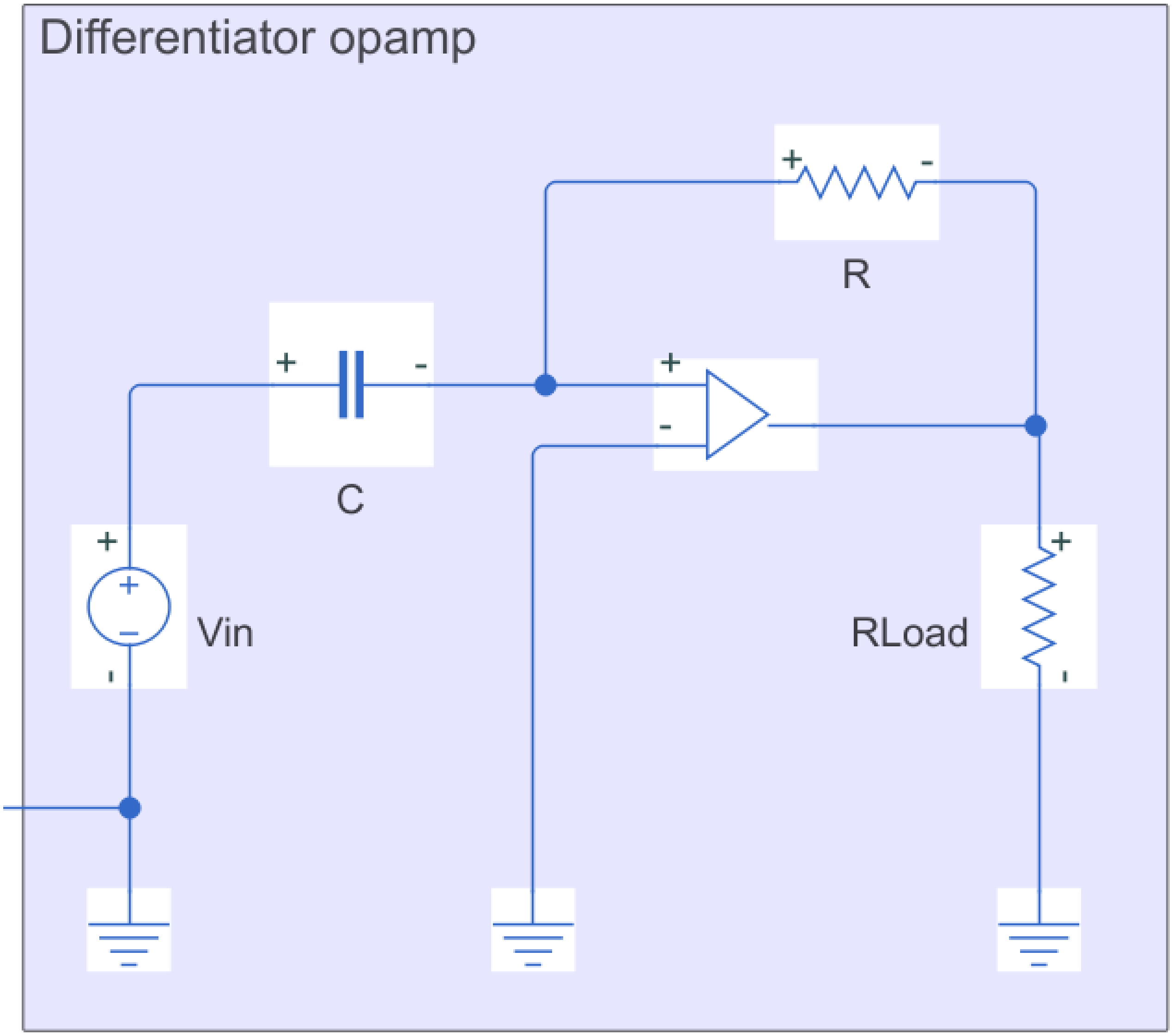
Differentiators and integrators derivation



Since there are zero current and voltage throught and across the opamp terminals,

KVL_1 :

$V_{in} = Vc$

and

KVL_2 :

$KVL_2 : -V_{in} + V_c + R \times i + V_o = 0$

From a current and voltage characteristic behavior of a capacitor, we've got

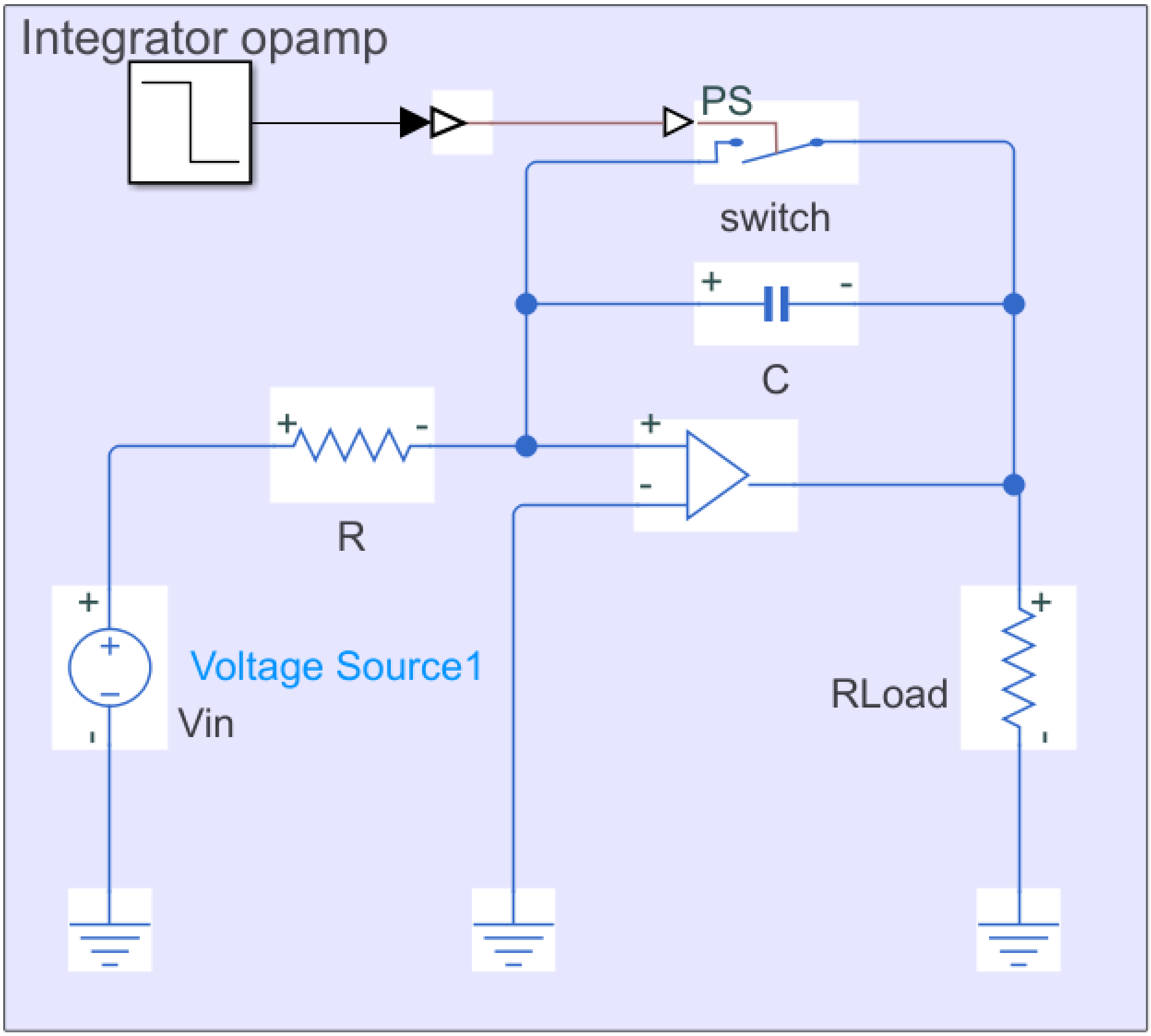
$i = C \frac{dVc}{dt}$

therefore

$V_o = -RC\dfrac{dVc}{dt}$ and, since $Vin = Vc$,

$$V_o = -RC\frac{dV_{in}}{dt}$$

The $-RC$ constant is the gain of this circuit, our design goal is to chose a value of RC that's meet some requirement.



The analysis is the same as before, except that we have a switch that controls how the current will flow through the circuit

For $t < 0$:

KVL_1 :

$V_{in} = iR$

and

$KVL_2 : -V_{in} + iR + V_o = 0$, therefore $V_o = 0$

For $t > 0$:

KVL_2 :

$-V_{in} + iR + V_c + V_o = 0$ and again using the current and voltage characteristic equation, $i = C\frac{dVc}{dt}$, but using integral calculus to get the voltage across the capacitor $V_c = \frac{1}{C}\int_0^t idt$, we've got

$$V_o = -\frac{1}{C}\int_0^t idt$$

or using the relationship $i = \frac{V_{in}}{R}$

$$V_o = -\frac{1}{RC}\int_0^t V_{in}dt$$

The $\frac{-1}{RC}$ constant is the gain of this circuit, our design goal is to chose a value of RC that's meet some requirement.