Basic Elec. Engr. Lab

ECS 204

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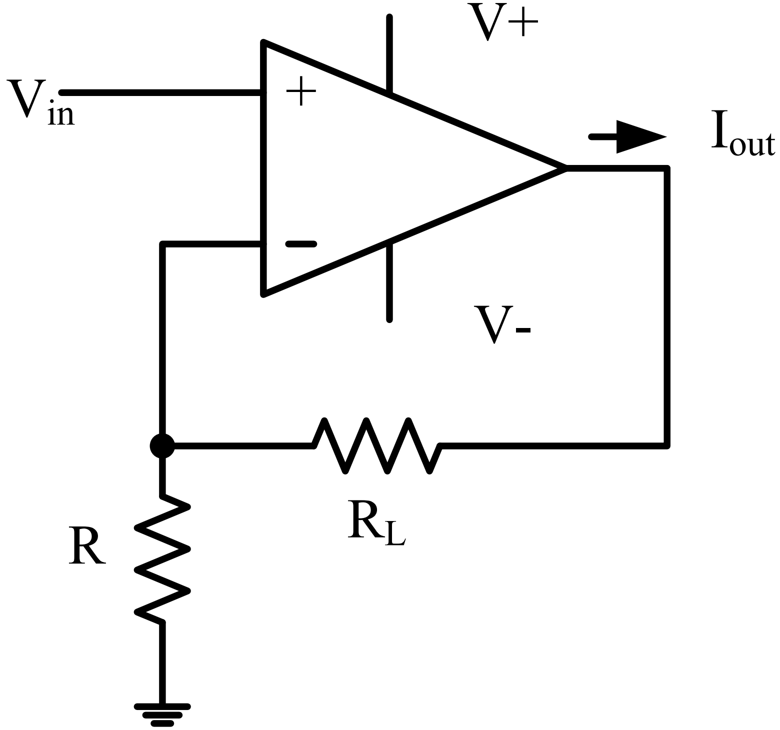
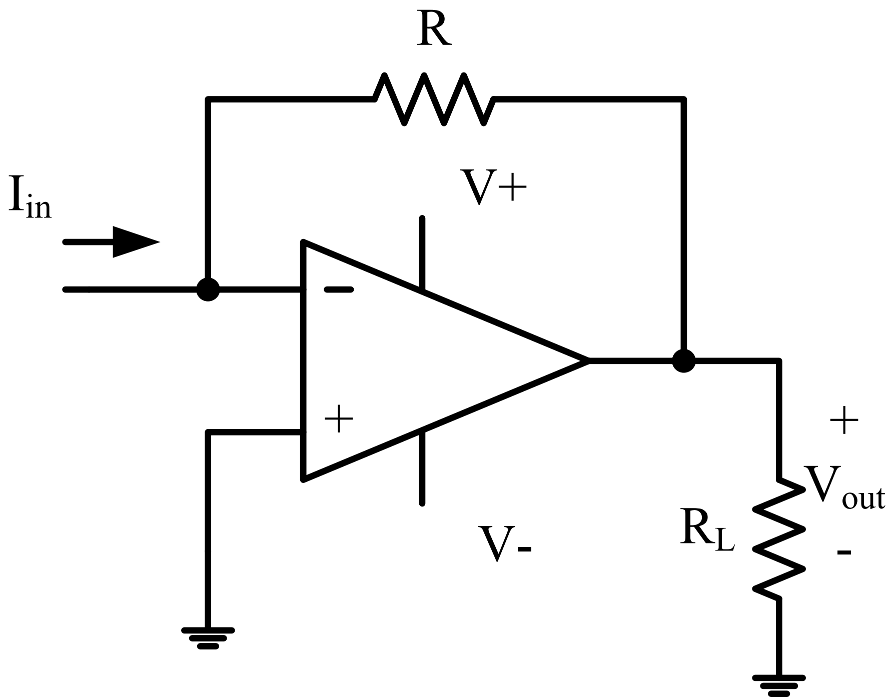
Lab 8

- Operational amplifier
- V2I and I2V Converters
- Inverting Integrator

V2I and I2V Converters

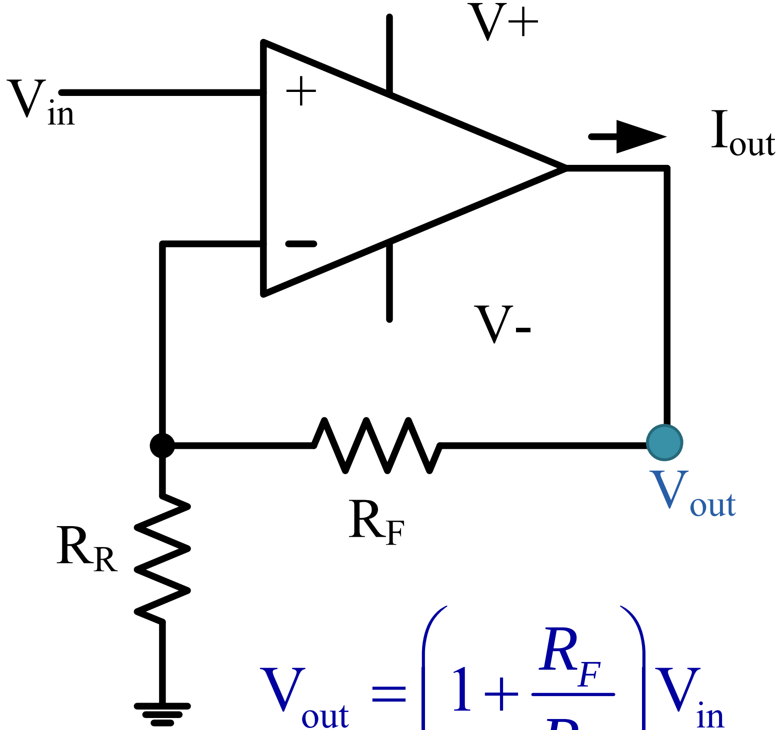


V2I Converter



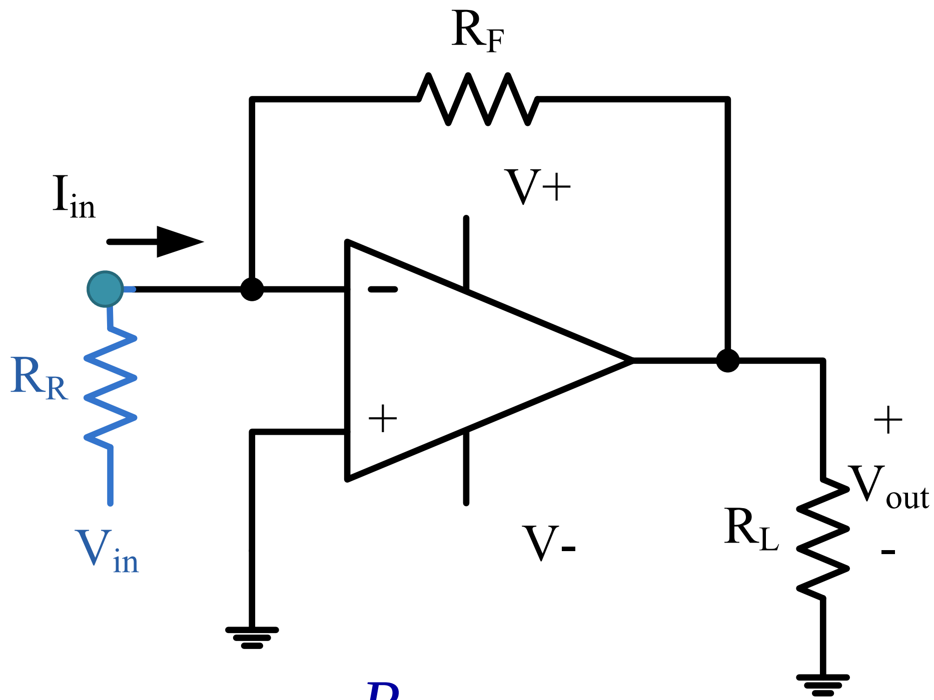
I2V Converter

V2I and I2V Converters



$$V_{out} = \left(1 + \frac{R_F}{R_R}\right) V_{in}$$

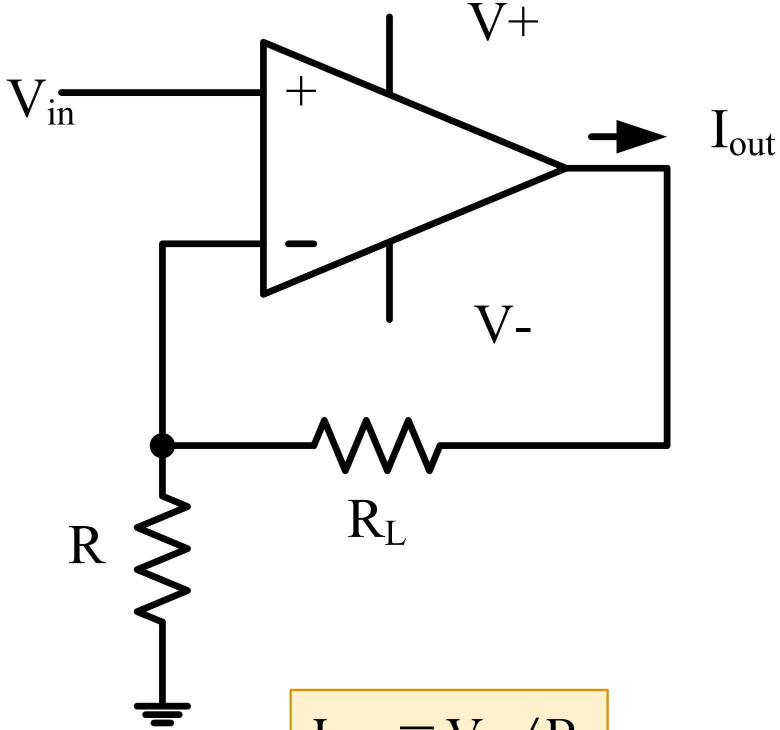
Non-inverting Amplifier



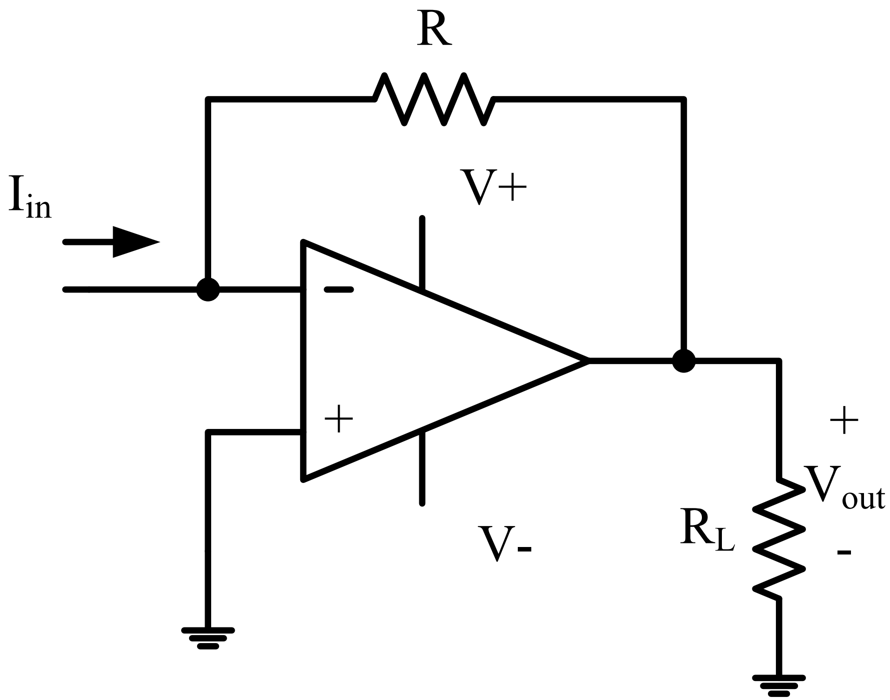
$$V_{out} = -\frac{R_F}{R_R} V_{in}$$

Inverting Amplifier

V2I and I2V Converters



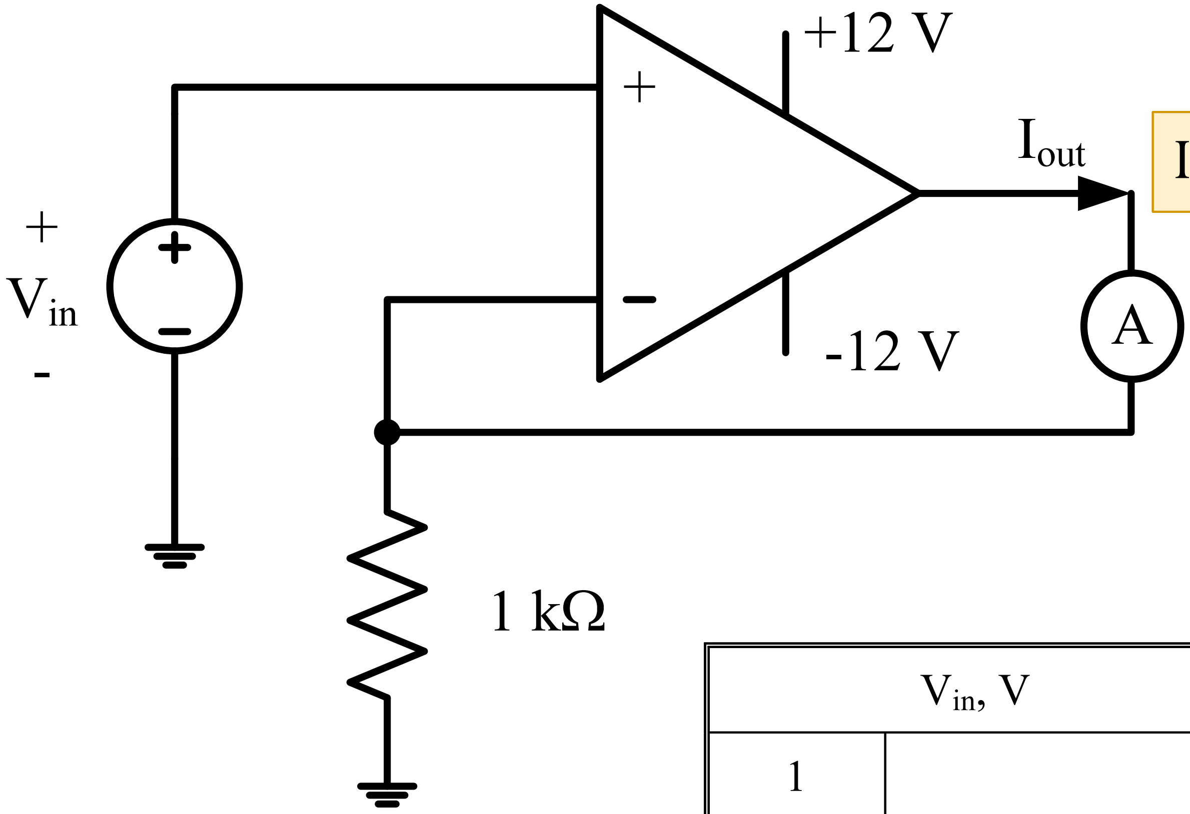
$$I_{out} = V_{in}/R$$



$$V_{out} = -I_{in}R$$

These relations hold regardless of the value of R_L.

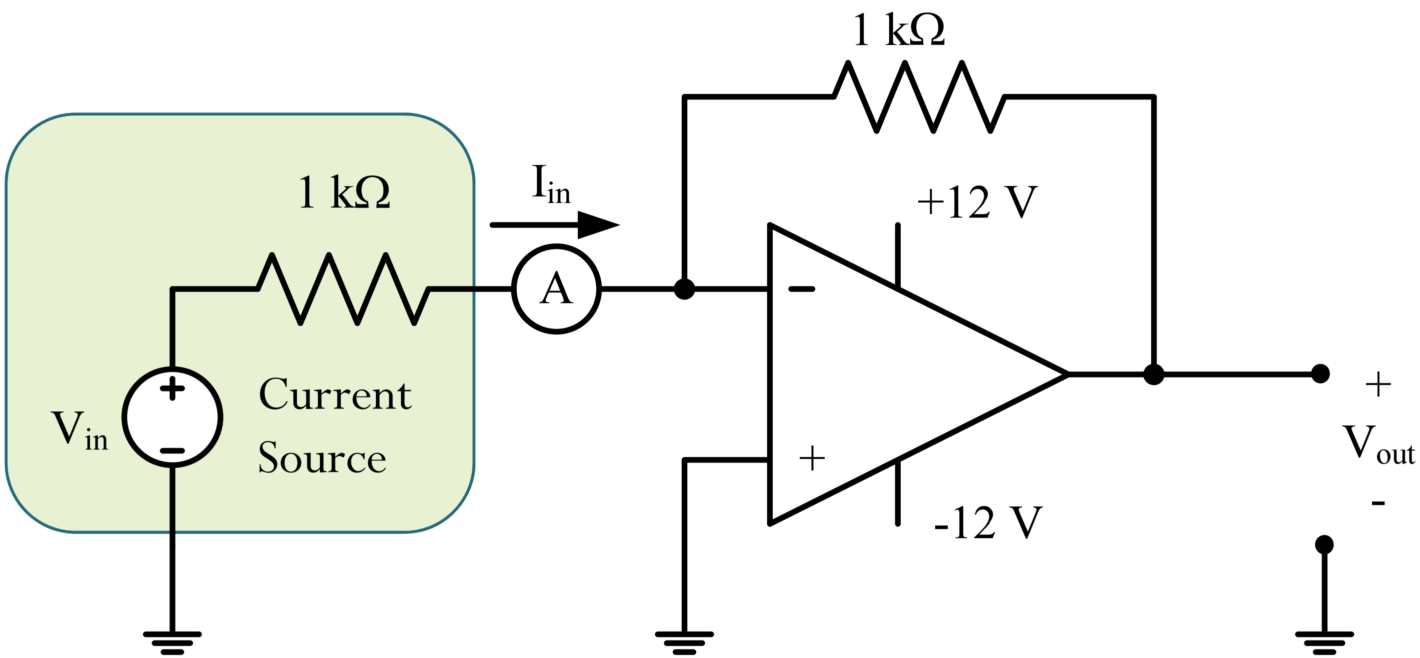
A: Voltage-to-current converter



$I_{out} = V_{in}/R$

V_{in}, V		I_{out}, mA
1		
3		
6		
10		

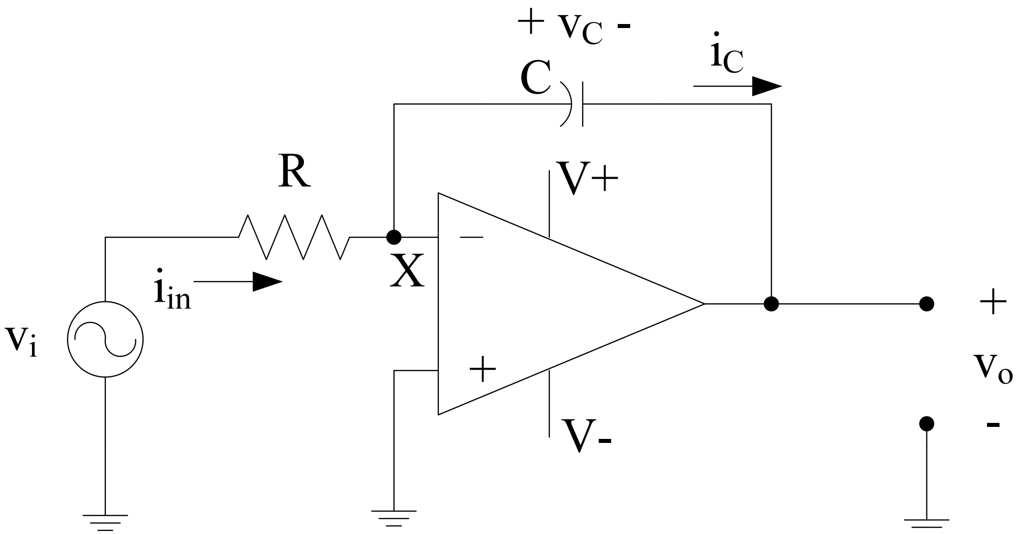
B: Current-to-voltage converter



$$V_{out} = -I_{in}R$$

I_{in}, mA		V_{out}, V
1		
3		
6		
10		

Part C: Inverting Integrator

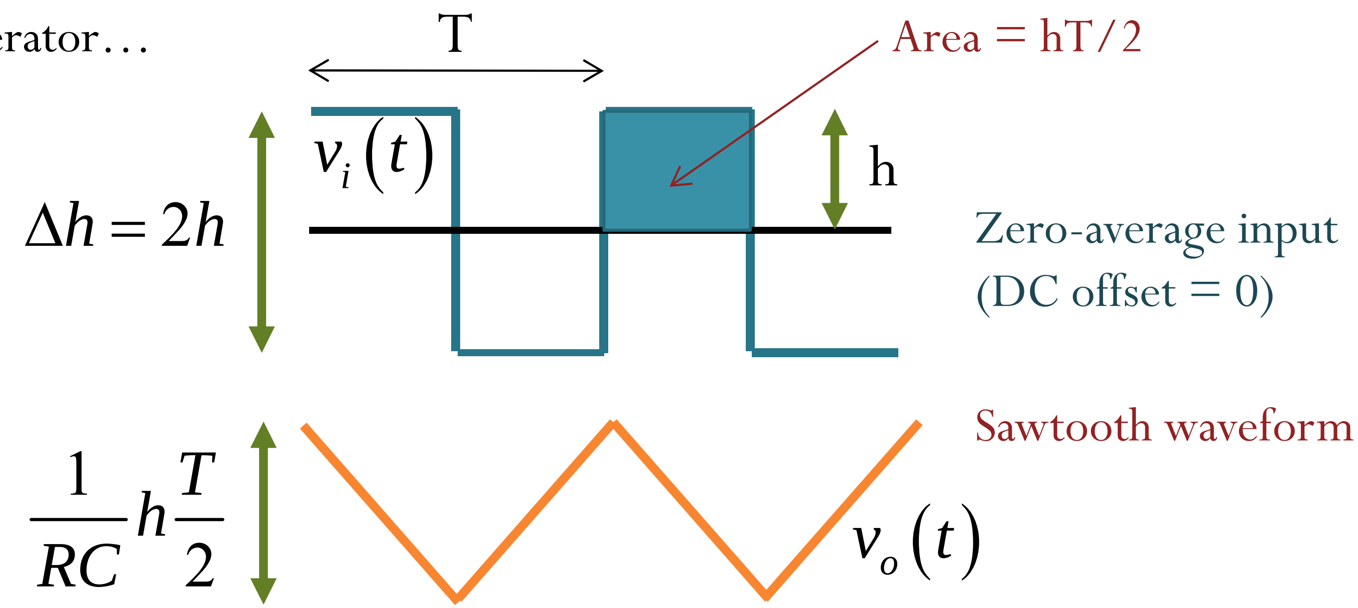


$$i_i(t)=i_C(t)$$

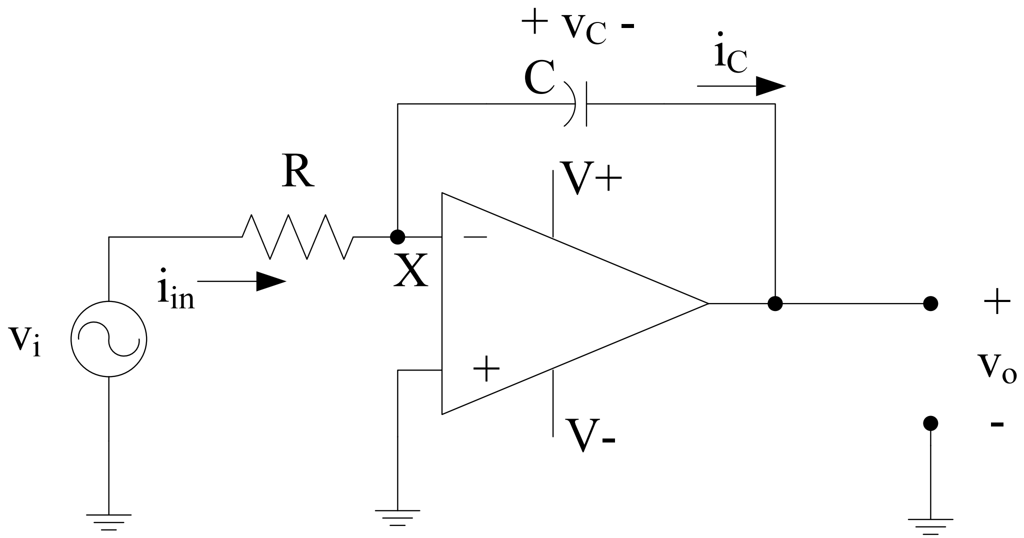
$$\frac{v_i(t)}{R}=-C\frac{d}{dt}v_o(t)$$

$$v_o(t)=v_o(0)-\frac{1}{RC}\int_0^t v_i(t)\,dt$$

As a Ramp Generator…



Inverting Integrator (2)

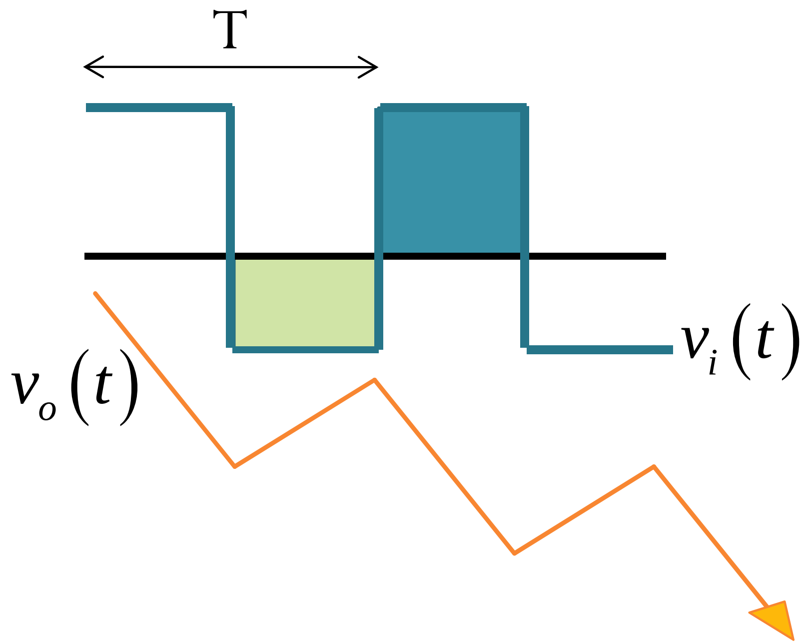


$$i_i(t) = i_C(t)$$

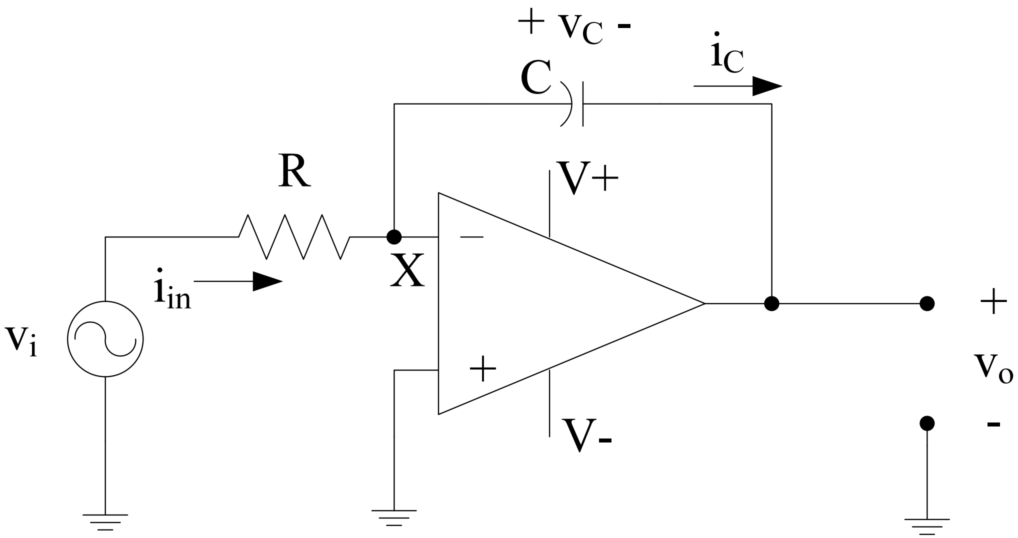
$$\frac{v_i(t)}{R} = -C\frac{d}{dt}v_o(t)$$

$$v_o(t) = v_o(0) - \frac{1}{RC}\int_0^t v_i(t)\,dt$$

- An input with nonzero mean (DC offset) can saturate the op amp.



Inverting Integrator: AC SS Analysis



$$V_o = -\left(\frac{Z_C}{R}\right)V_i$$

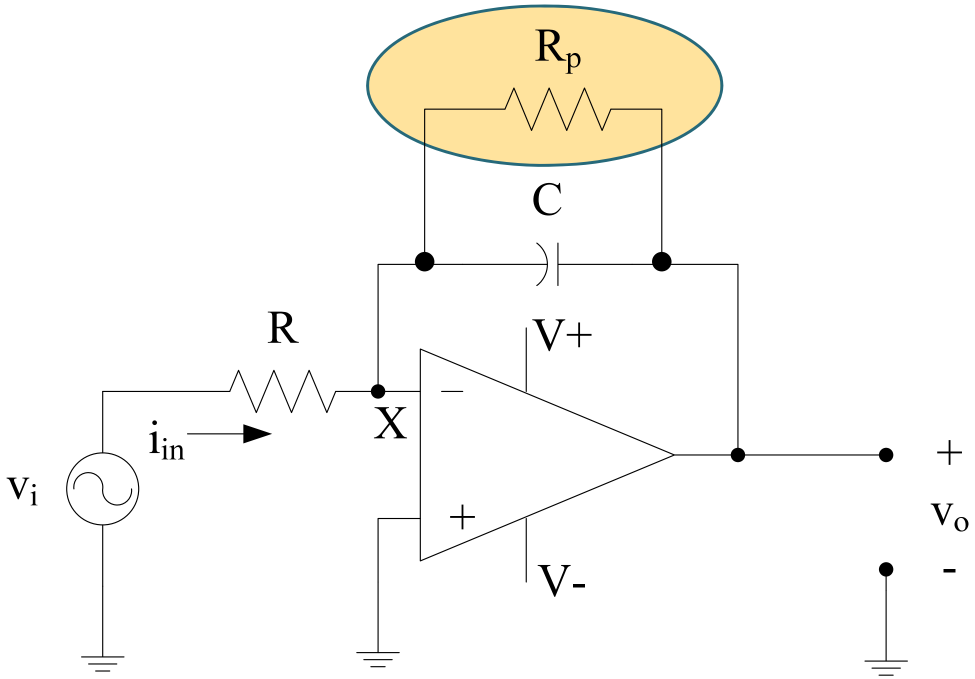
$$= -\left(\frac{V_i}{R}\right)\times\frac{1}{j\omega C}$$

- The gain at $f = 0$ is unbounded.
- Act like an **active low pass filter**, passing low frequency signals while attenuating the high frequencies.

(w/ DC Gain Control)

Inverting Integrator w/ Shunt Resistor

- In practical circuit, a large resistor R_p is usually shunted across the capacitor

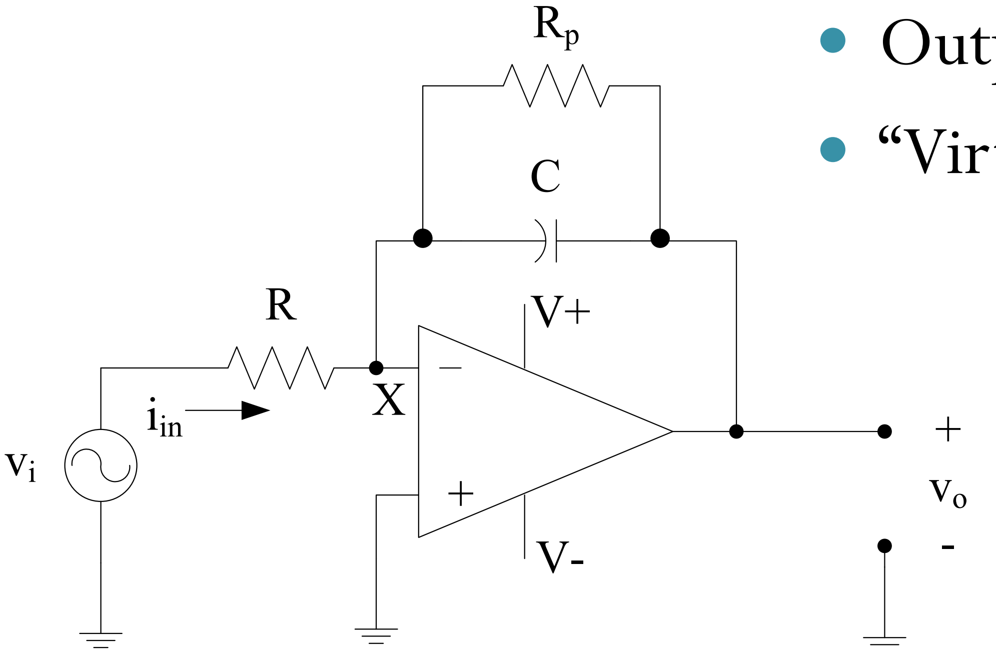


$$V_o = -\left(\frac{Z_C // R_p}{R}\right) V_i$$

$$= -\left(\frac{V_i}{R}\right) \times \frac{R_p}{j\omega R_p C + 1}$$

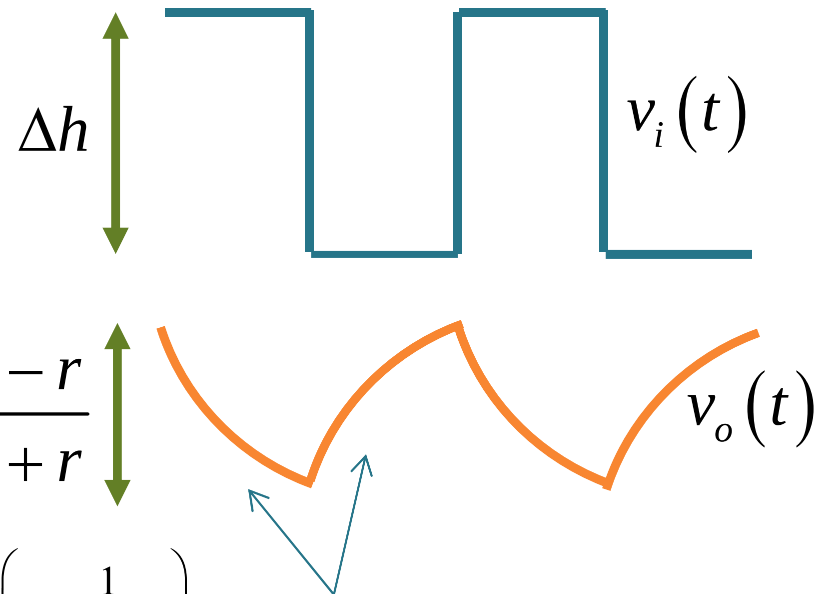
- Observe that at $f = 0$, the gain is finite.

Inverting Integrator w/ Shunt Resistor



- Output is <u>*not*</u> triangular.
- "Virtually triangular" if $R_p C \gg \frac{T}{2}$

$$R_p \gg \frac{1}{2fC} \qquad C \gg \frac{1}{2fR_p}$$



$$\Delta h \frac{Rp}{R}\frac{1-r}{1+r}$$

$$r = \exp\left(-\frac{1}{2fR_pC}\right)$$

$$\tau = R_p C$$