Basic Elec. Engr. Lab

ECS 204/210

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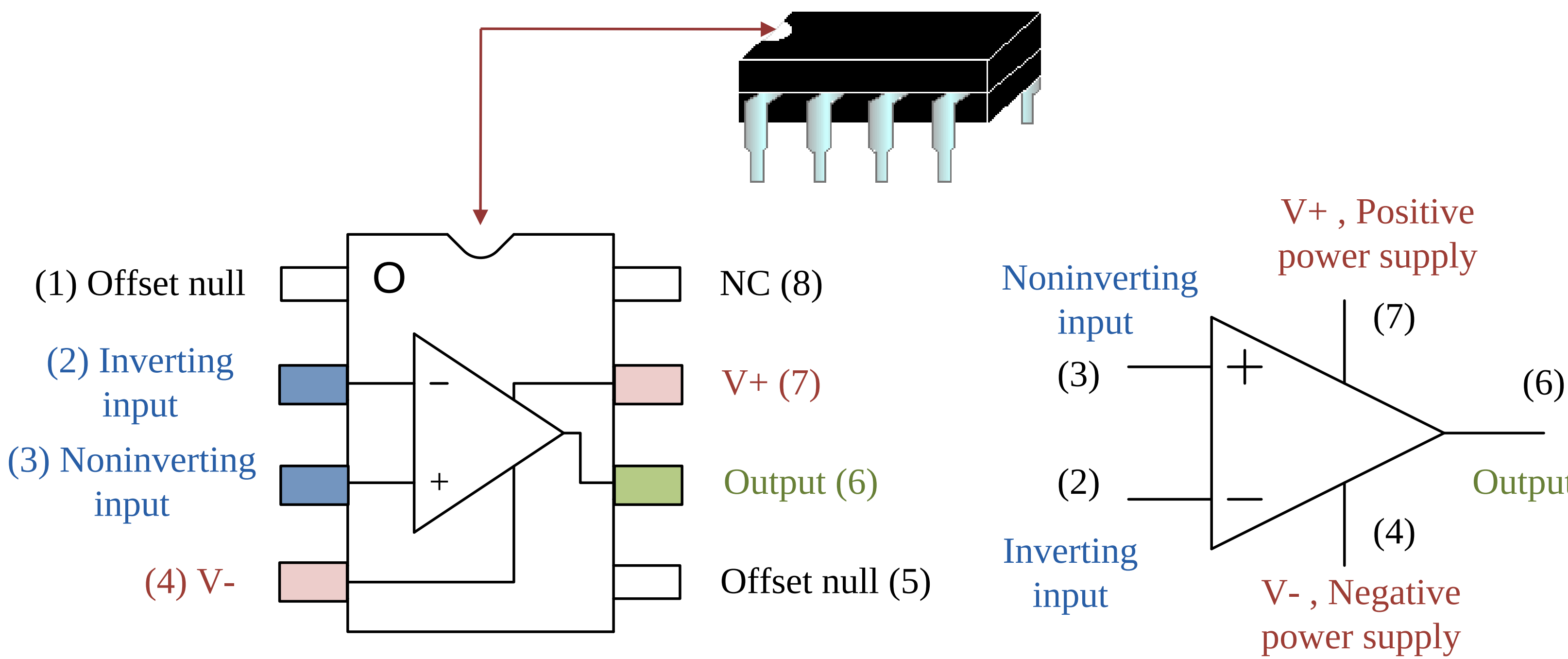
Office Hours:
BKD 3601-7
Tuesday 9:30-10:30
Friday 14:00-16:00

Lab 7

- Operational amplifier
- Inverting amplifier
- Inverting Integrator

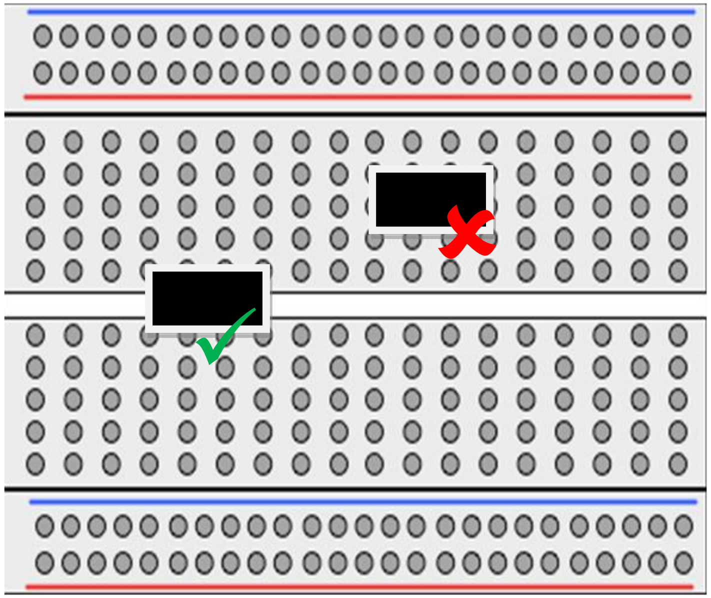
Op-Amp 741

- **OP**erational **AMP**lifier



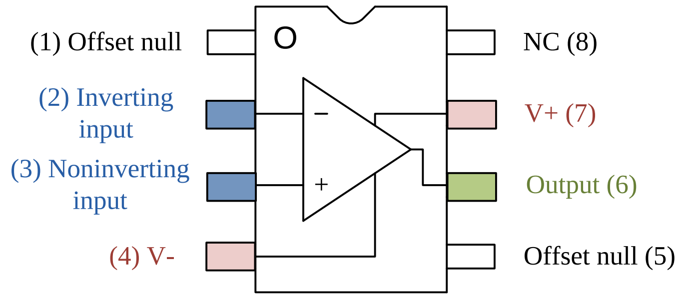
Placing op amps on the proto-board

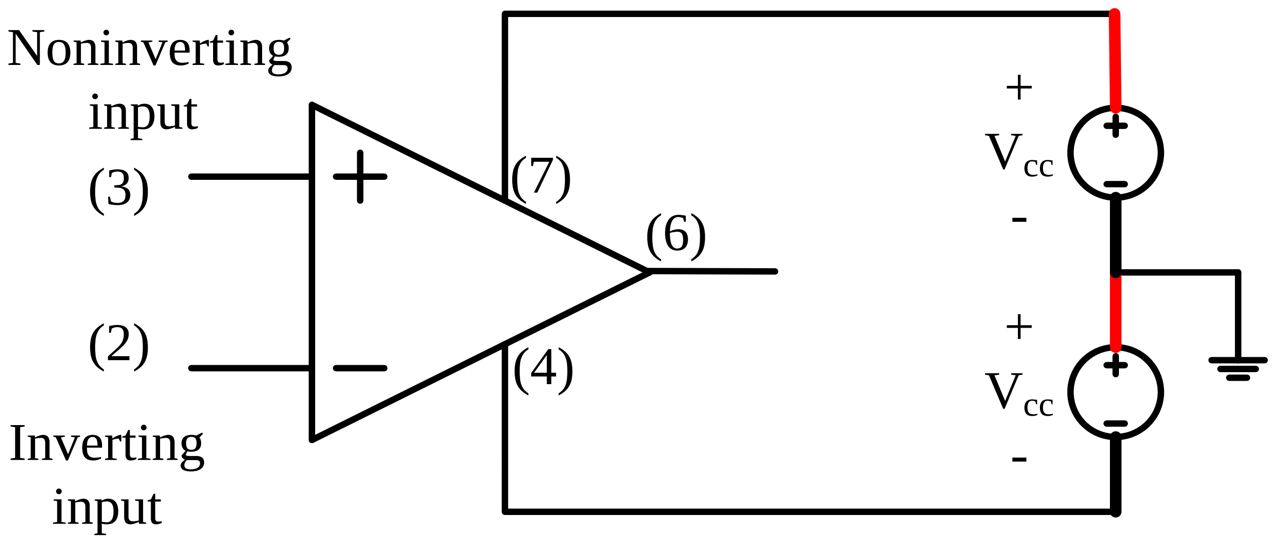
- Plug in op amp chips so that they straddle the troughs on the proto board.
- In this way, each pin is connected to a different hole set.



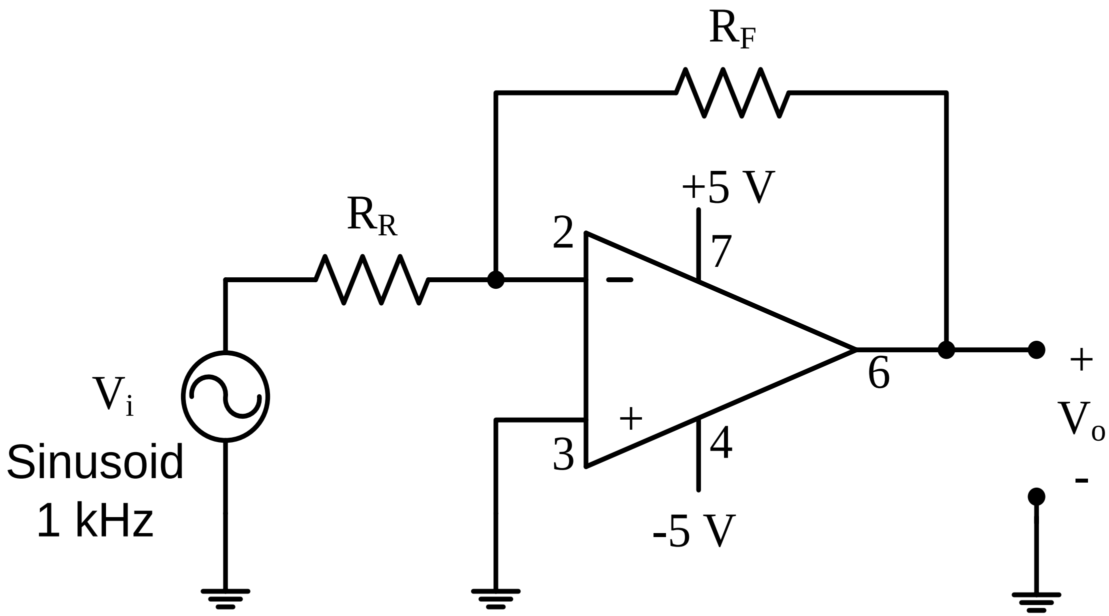
Powering the op amp

- The op amp must be powered by voltage supplies.
- These supplies are often ignored in op amp circuit diagrams for the sake of simplicity.



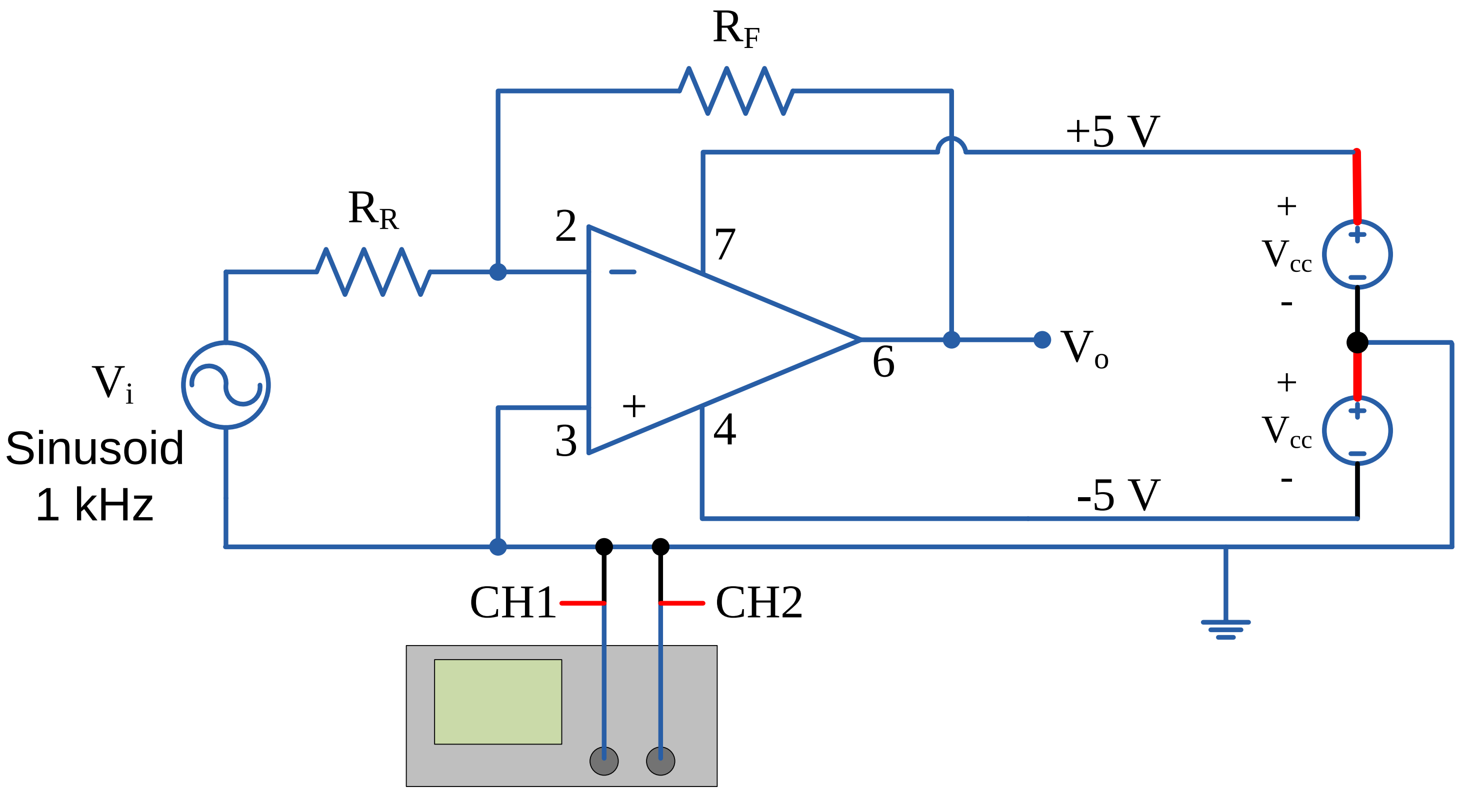


Part A: Inverting Amplifier

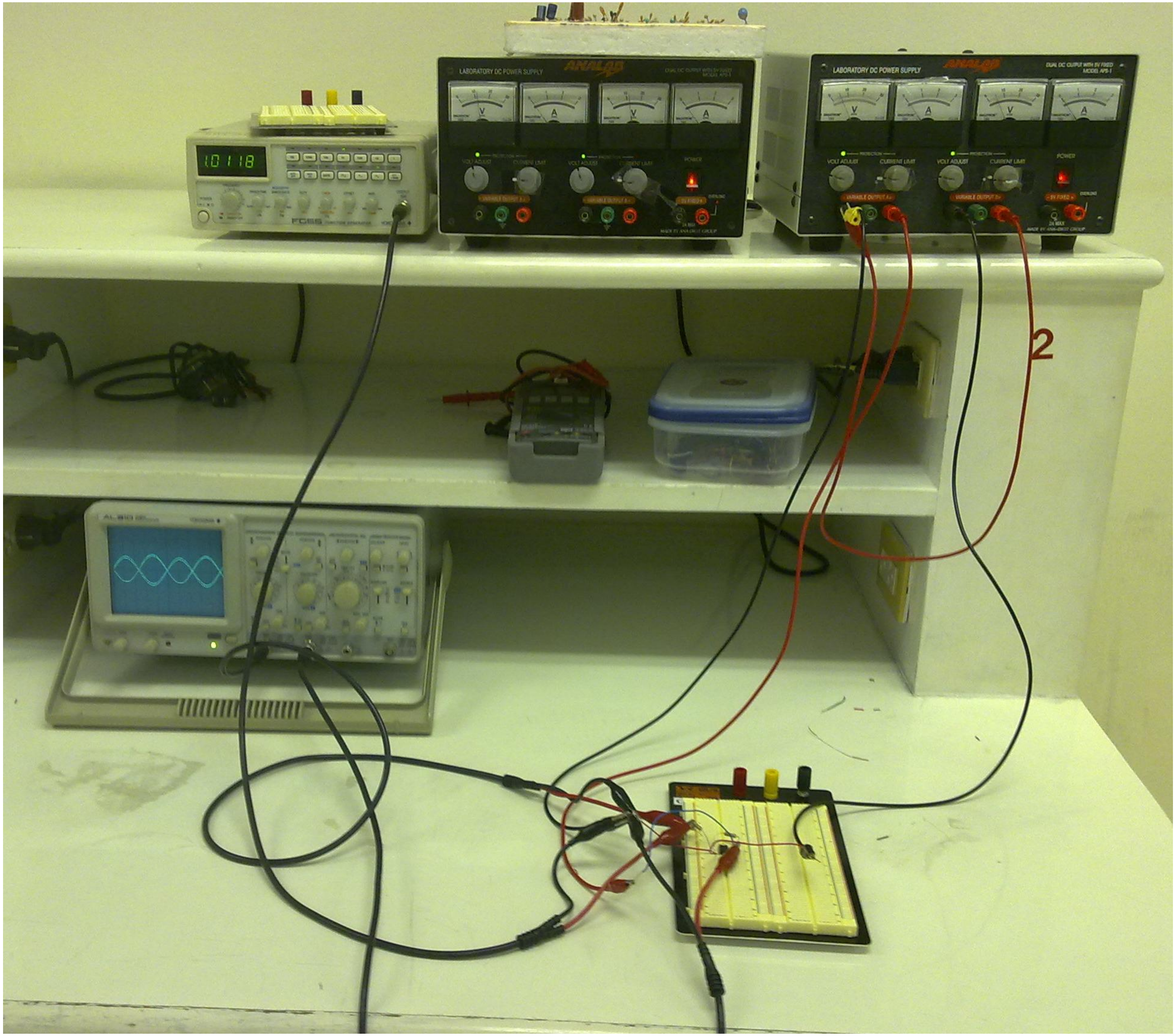


$$V_o = -\frac{R_F}{R_R} V_i .$$

Part A: Inverting Amplifier



$$V_o = -\frac{R_F}{R_R} V_i.$$


LABORATORY DC POWER SUPPLY
ANALAB
LABORATORY DC POWER SUPPLY
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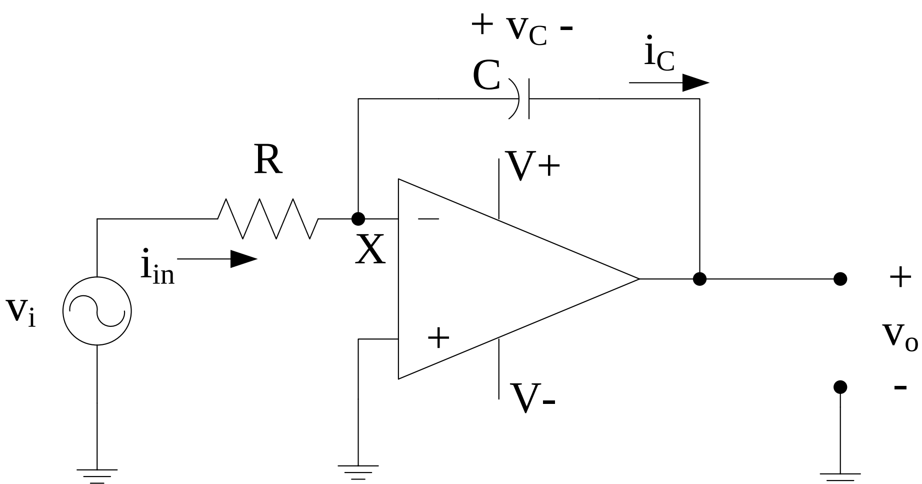
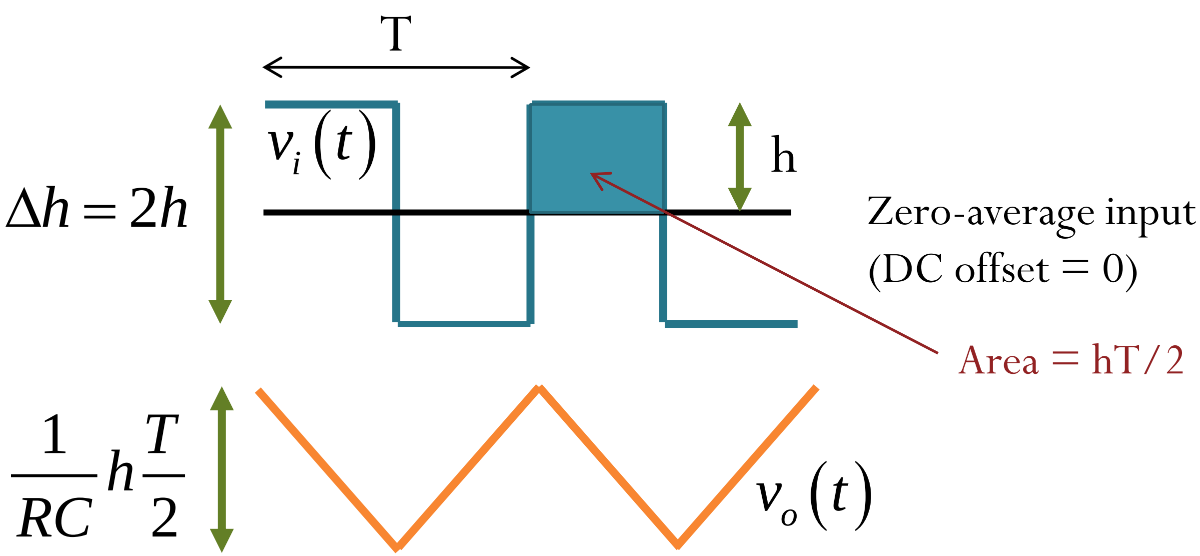
Part B: Inverting Integrator



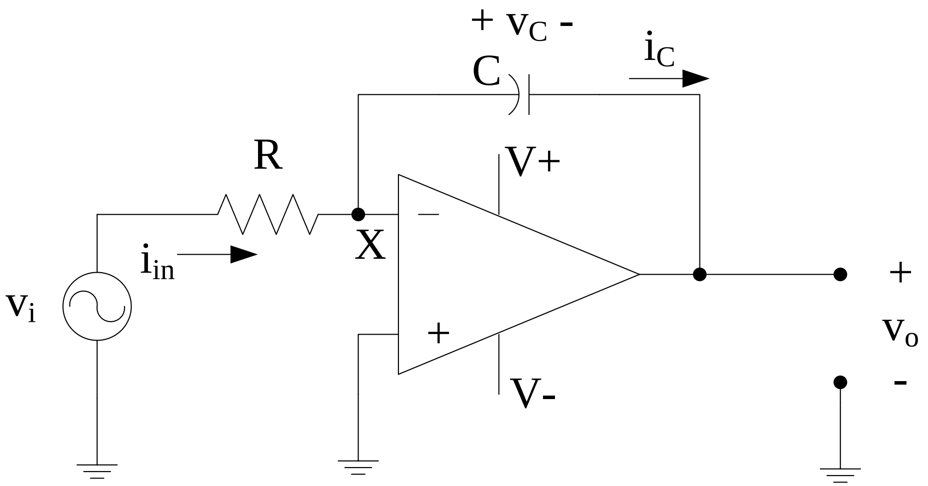
$$i_i(t) = i_C(t)$$

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

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



Inverting Integrator (2)

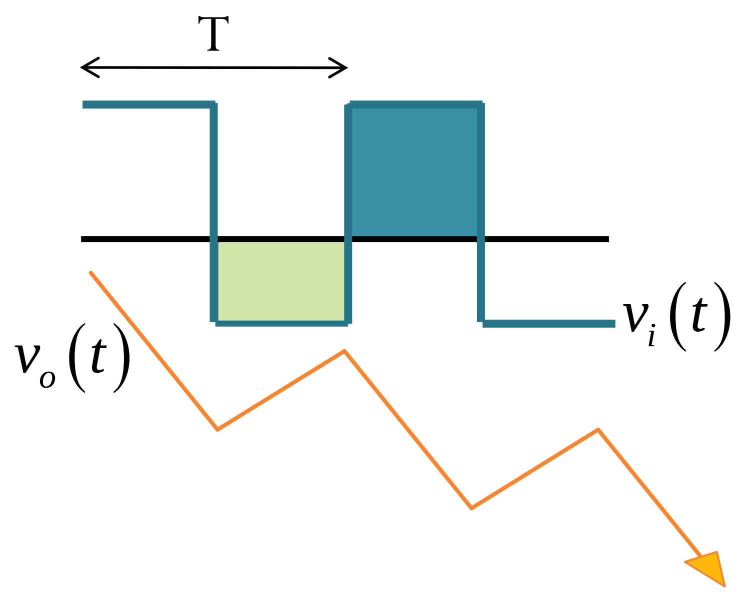


$$i_i(t) = i_C(t)$$

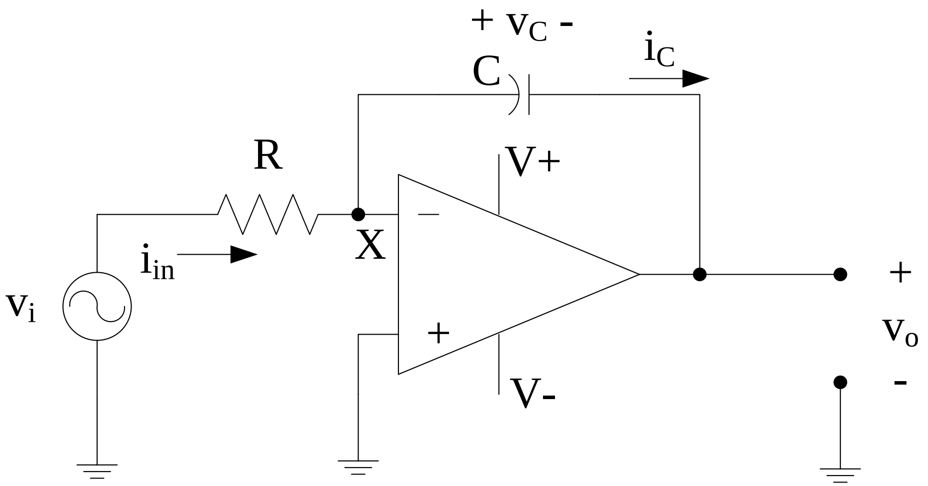
$$\frac{v_i(t)}{R} = -C\frac{d}{dt}v_o(t)$$

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

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



Inverting Integrator: AC SS Analysis



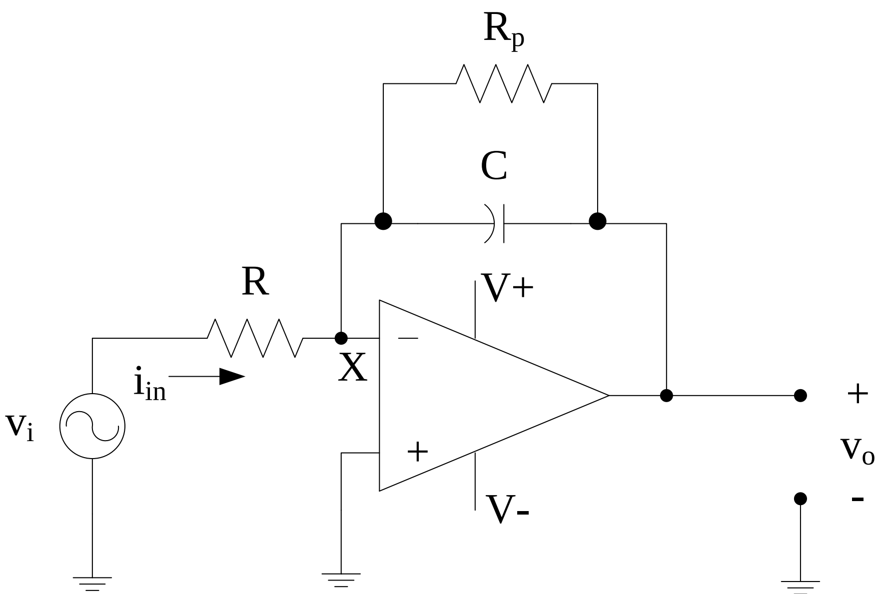
$$V_o = -\left(\frac{Z_C}{R}\right)V_i$$

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

- The gain at $f = 0$ is unbounded.

Inverting Integrator w/ Shunt Resistor

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

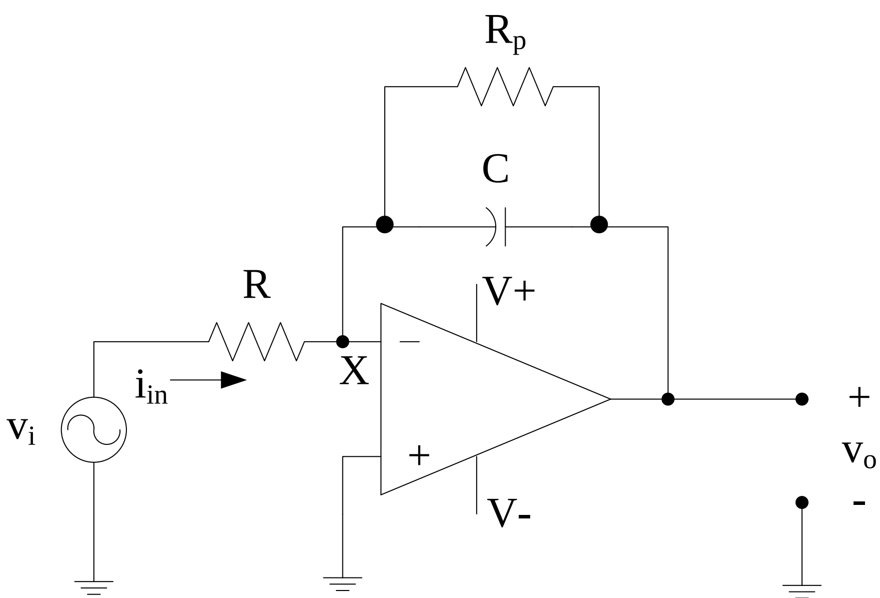


$$V_o = -\left(\frac{Z_C // R_p}{R}\right) V_i$$

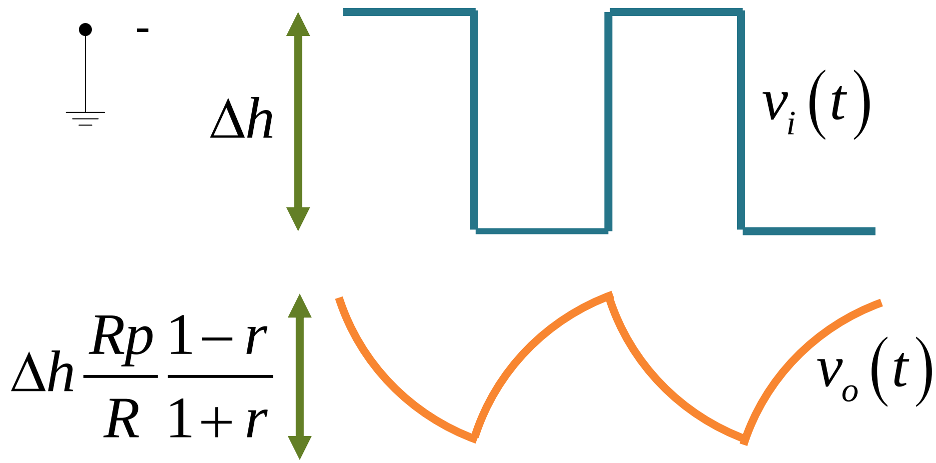
$$= -\left(\frac{V_i}{R}\right) \times \frac{R_p}{j\omega R_p C + 1}$$

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

Inverting Integrator w/ Shunt Resistor



- The output will ***not*** be triangular anymore.
- "Virtually triangular" if $R_pC >> T/2$.



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