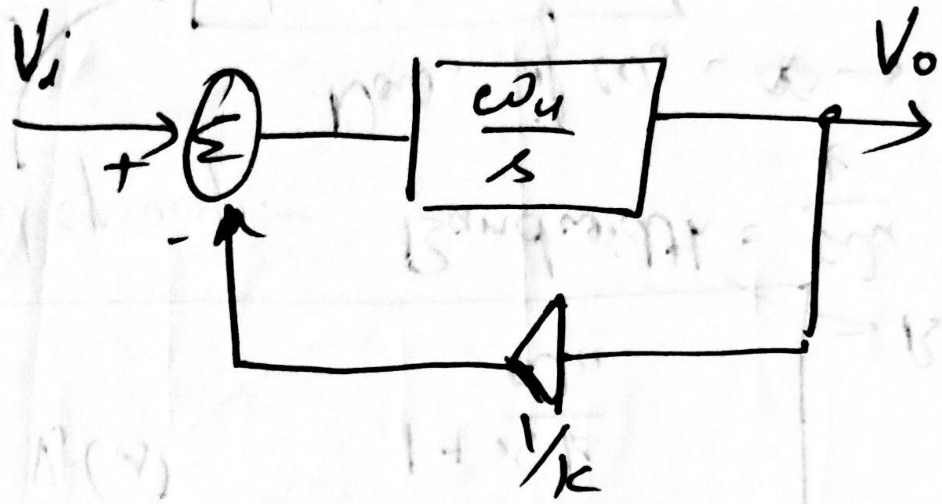
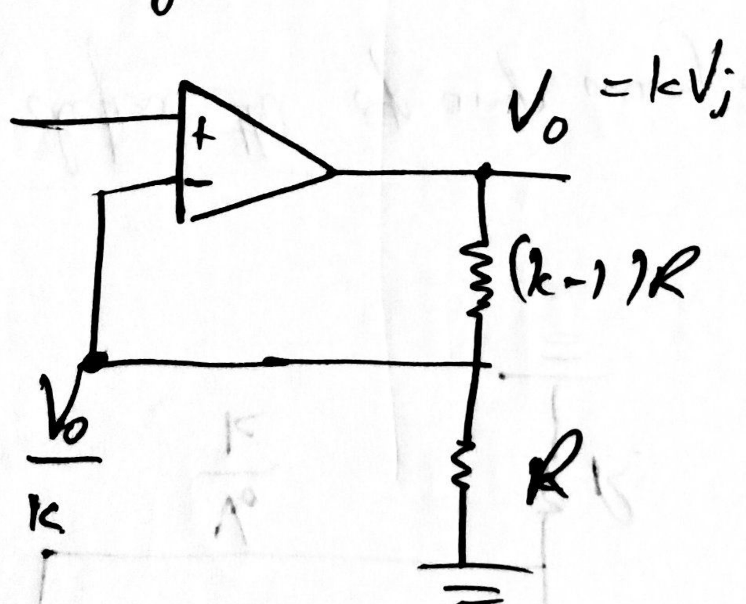
Negative feedback Amp:-



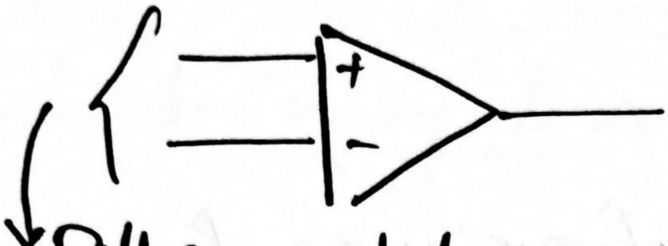
* Other amplifiers using an op-amp.

① VCVS [Voltage Controlled Voltage Source]



② CCVS [Current Controlled Voltage Source]

$\hookrightarrow$ $V_o = R_f \cdot I_i$

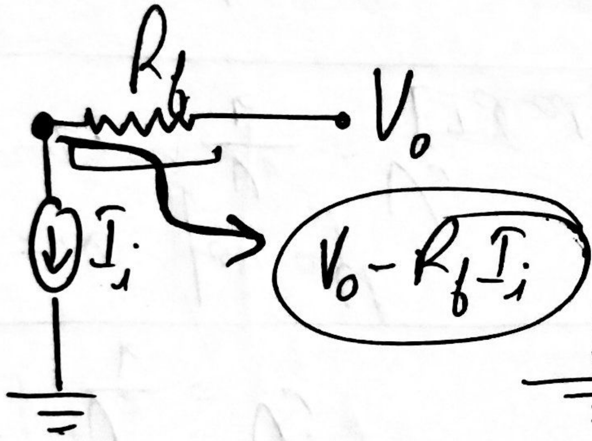


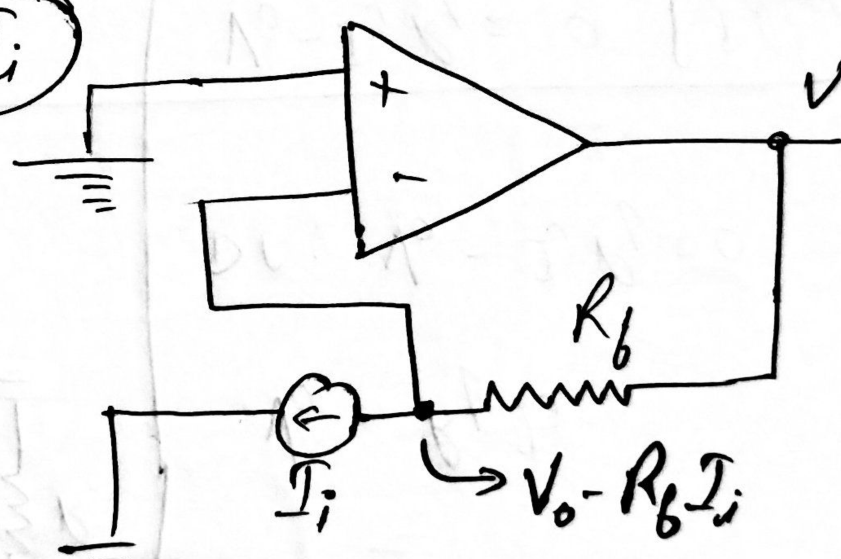
Difference between voltages

$V_o = R_f I_i$

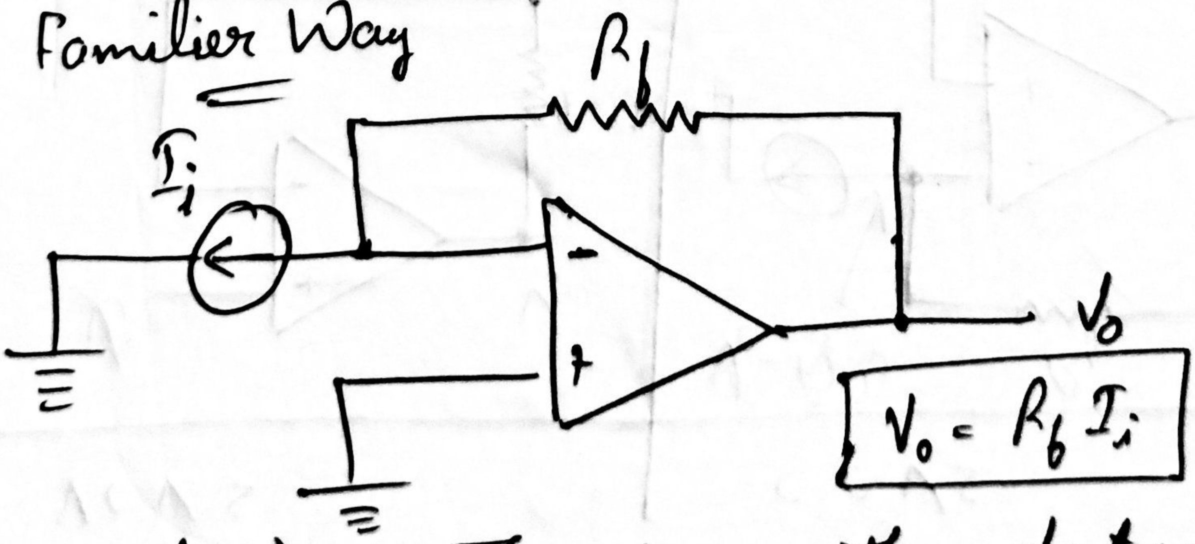
$V_o - R_f I_i > 0 \rightarrow$ Reduce V_o

$V_o - R_f I_i < 0 \rightarrow$ Increase V_o



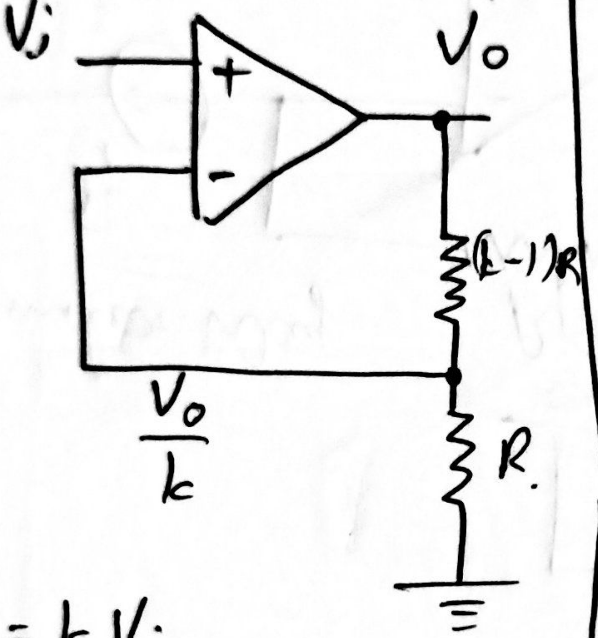
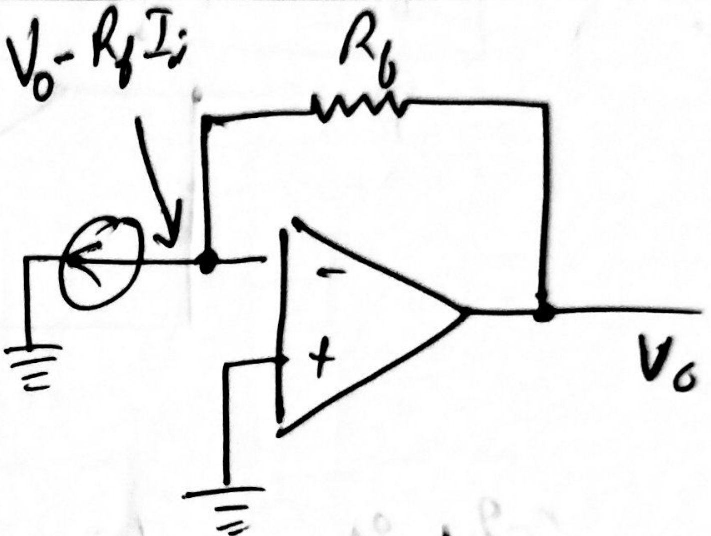


Familier Way



I_i (dc) → The only way the output will reach a steady value by $V_o = R_f I_i$.

* Summary

VCVS	CCVS
	
$V_o = k V_i$	$V_o = R_f I_i$
DC: $\frac{V_o}{k} = V_i$	DC: $V_o - I_i R_f = 0$
$\omega_n = \infty$ for all freq. $\rightarrow \frac{V_o}{k} = V_i$ [Ideal]	$V_o - I_i R_f = 0$ [Ideal]

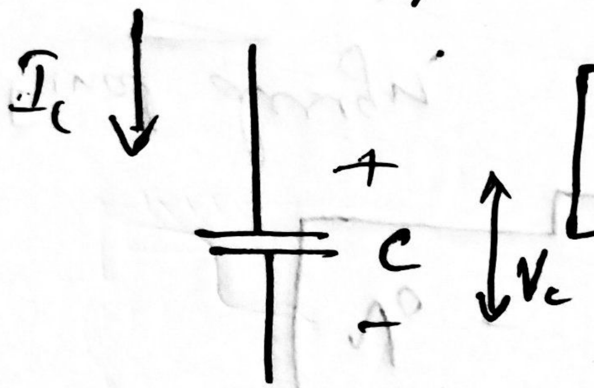
* How to design an op-amp?

(1) Design an integrator.

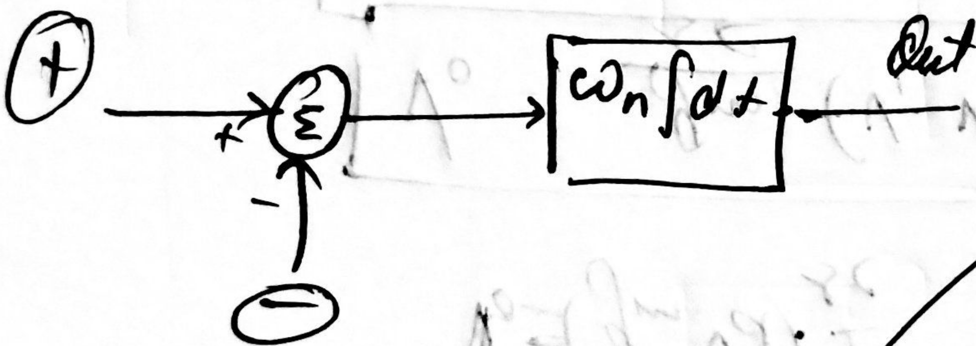
Integrator Realization

→ Integrator using L or $\boxed{C}$ → Best choice

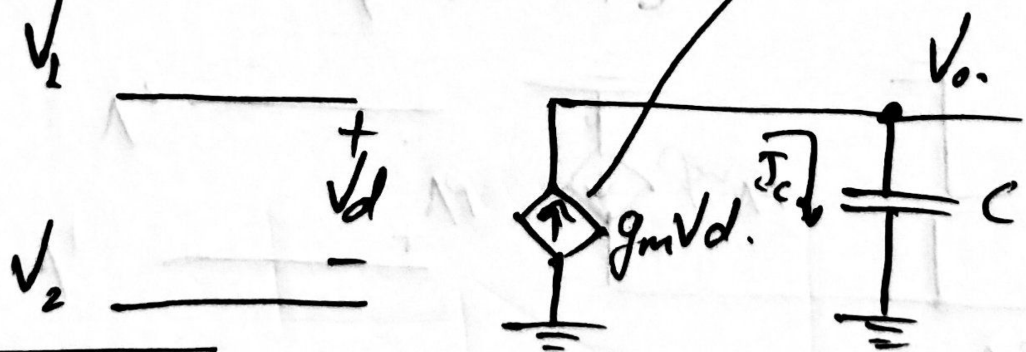
L: Impractical [Cause bulky]



$$\boxed{V_c = \frac{1}{C}\int I_c\,dt}$$



Voltage Controlled Current Source [Latter]



$$\boxed{V_d = V_1 - V_2}$$

$I_c = g_m V_d$

Now, $V_o = \frac{1}{C}\int I_c\,dt$

$V_o = \frac{g_m}{C}\int V_d\,dt$

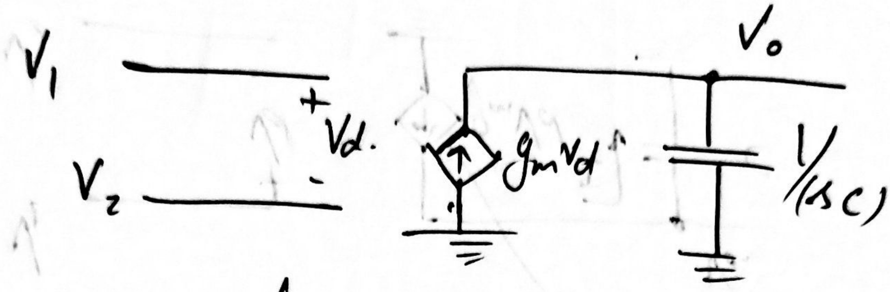
so, $\boxed{V_o = \frac{g_m}{C}\int (V_1 - V_2)\,dt}$ → $\boxed{V_o = \omega_u \int V_d\,dt}$

So,

$$\boxed{V_0 = \omega_u \int (V_1 - V_2)\, dt} \qquad \boxed{\omega_u = \frac{g_m}{C}}$$

In frequency domain :-

$V = IZ$



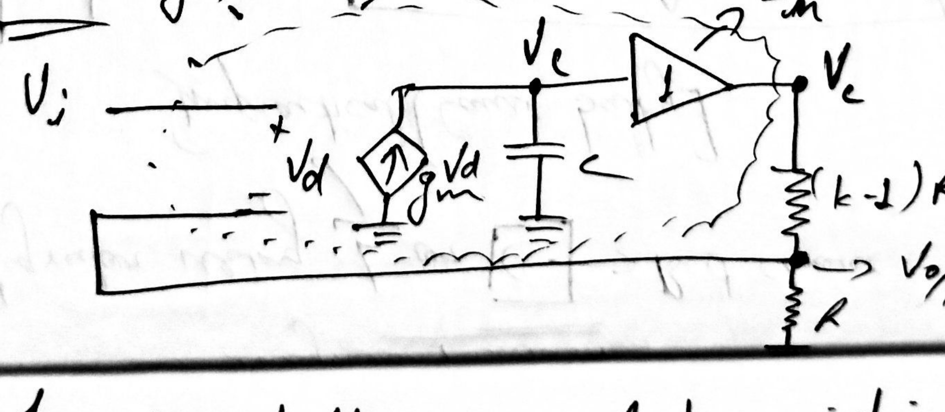
$$V_0 = (g_m V_d)\frac{1}{sC} \qquad Z = \frac{1}{sC}$$

$$\boxed{V_0 = \frac{g_m}{sC}(V_1 - V_2)}$$

$$\boxed{V_0 = \frac{\omega_u}{s}(V_1 - V_2)}$$

Final design → op-amp. [VCVS]

$Z_{in} = \infty$ [Buffer]



→ The voltage buffer is used to maintain the application of the design, if we don't use the buffer the some current will be drawn by the voltage divider used to get $\left(\frac{V_0}{k}\right)$.