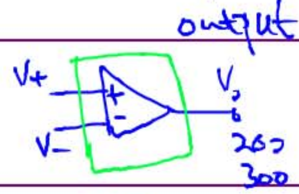
[illegible]

Amplifier

numerical competation

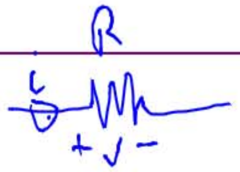


ideal / amplifier

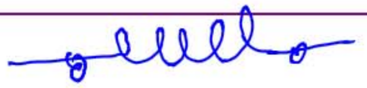
operational amplifier 741

2 rules / operation +, -, *, ÷

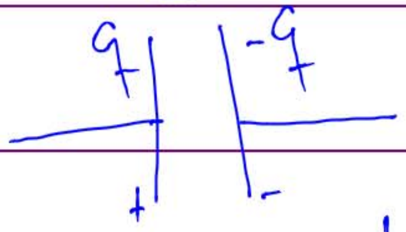
$\int$ $\frac{d}{dt}$



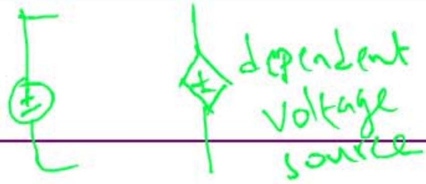
$p(t) = i(t) * v(t)$



C $C = \frac{q}{V}$



$V = V_+ - V_-$



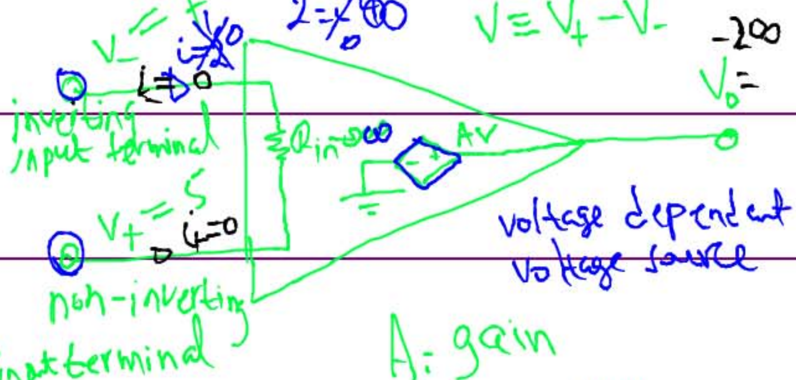
$V = iR$

$2 = i \cdot \infty$

$5 - 7 = -2V$

$V = V_+ - V_-$

ve/t
ground
=
0 volt



A: gain
~ 100000

$V_o = AV$

Ideally

$\infty \Rightarrow V_+ - V_- = 0$

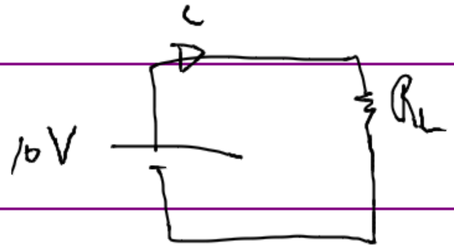
Ideally, $V = 0 \rightarrow V_+ = V_-$

① No current goes into the input terminals

$A(V_+ - V_-) = V_o$

② V_o is independent of what is connected to the amplifier

Load



good amplifier (eg. 741)

$A \longrightarrow \infty$

$A = 10$
100
600
700000
9×10^{12}

Approximation

① $\boxed{V_+ = V_-}$

② $\boxed{i_+ = i_- = 0}$

ideal

Two simple rules for analyzing OP AMP Circuits

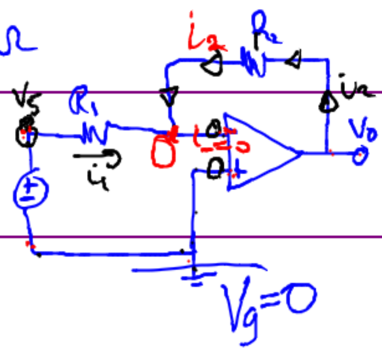
$V_+ = 4$
$V_- = 4$

$V \equiv V_+ - V_- = 0$

$R_1 = 400\Omega$
$R_2 = 5000\Omega = 5k\Omega$

$V_s = 0.005$ V
$= 5mV$

V_s: signal potential



$V_o(R_1, R_2, V_s)$

KCL: $i_1 + i_2 = 0 \Rightarrow \boxed{i_2 = -i_1}$

$V_o - 0 = i_2 * R_2$

$V_o - 0 = i_2 R_2$

$V_s - 0 = i_1 R_1$

$V_o = -i_1 R_2$

$V_s = i_1 R_1$

$+ -$

$* \int \quad d/dt$

$$\frac{V_o}{V_s} = -\frac{R_2}{R_1}$$

inverting amplifier

$R_2 = R_1 = 4k\Omega$

$$\frac{V_o}{V_s} = -\frac{4000}{4000} = -1$$

$V_o = -V_s$

$$\frac{V_o}{V_s} = -\frac{5000}{400} = -12.5$$

$V_s = 5 mV$

$V_o = -5 * 12.5 = -62.5 mV$

$-625 mV$

non-inverting amplifier

$V_+ = V_-$

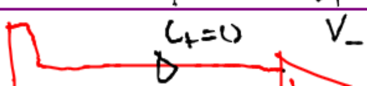
$i_+ = i_- = 0$ ✓

$V = 0 = V_+ - V_-$

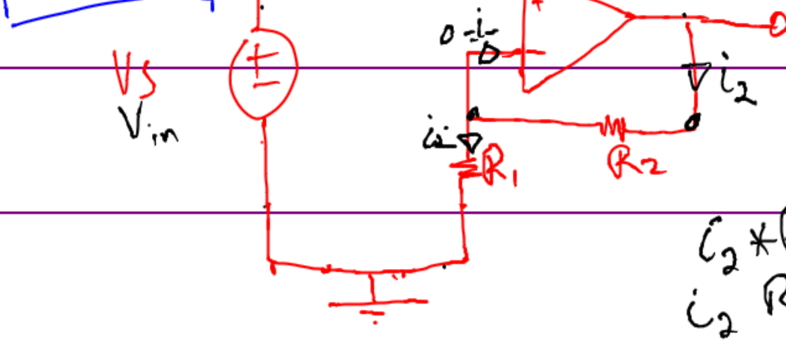
$V_+ = V_s$

$V_- = V_s$

$V_+ = V_-$



V_o



$$i_2 * R_2 = V_o - V_s$$
$$i_2 R_1 = V_s - 0$$

$$V_o = i_2 R_2 + i_2 R_1 = i_2 (R_1 + R_2)$$
$$V_s = i_2 R_1$$
$$\frac{V_o}{V_s} = \frac{i_2 (R_1 + R_2)}{i_2 R_1} = \frac{R_1 + R_2}{R_1}$$

$$\boxed{\frac{V_o}{V_s} = 1 + \frac{R_2}{R_1}}$$

$$V_o = \left(1 + \frac{R_2}{R_1}\right) V_s$$

$R_2 = 5000\ \Omega$
$R_1 = 400\ \Omega$
$V_s = -5\ mV$ ✓

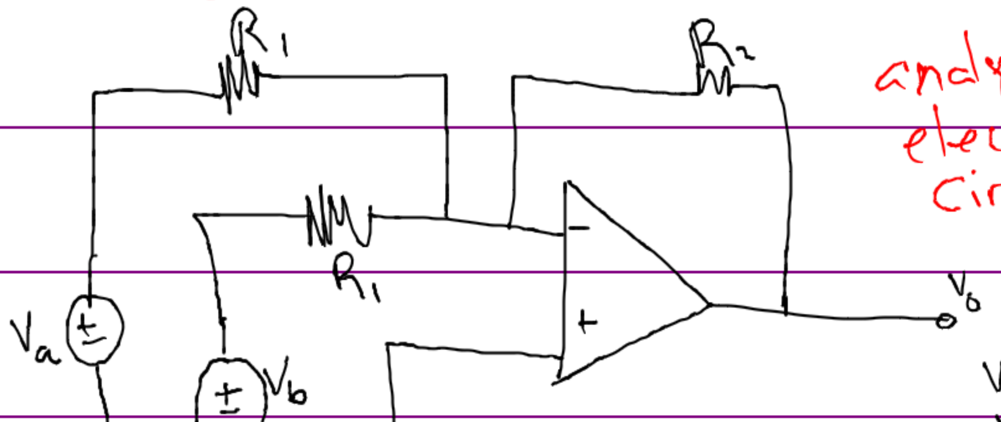
$V_o = 13.5 * 5\ mV$
$= -67.5\ mV$ ✓

$V_o = 40 V_a + 62 V_b$

Adding / Summing amplifier

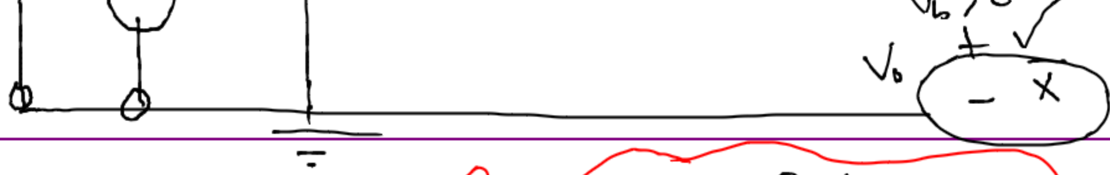
V_A, V_B $\quad V_o \approx V_A + V_B$
$60000 (V_A + V_B)$

Interaction:



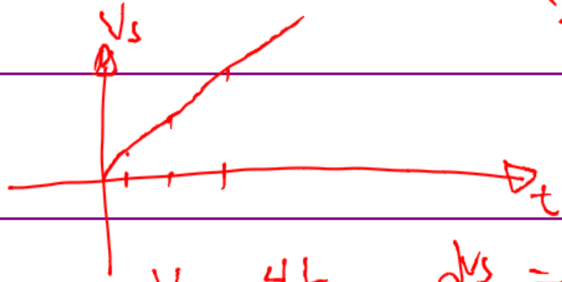
analysis of electronic circuits

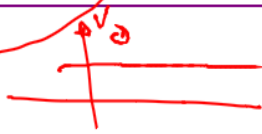
$V_a > 0$



?

$V_o = -\left(\frac{\ }{\ }\right)(V_a + V_b)$ R_1, R_2

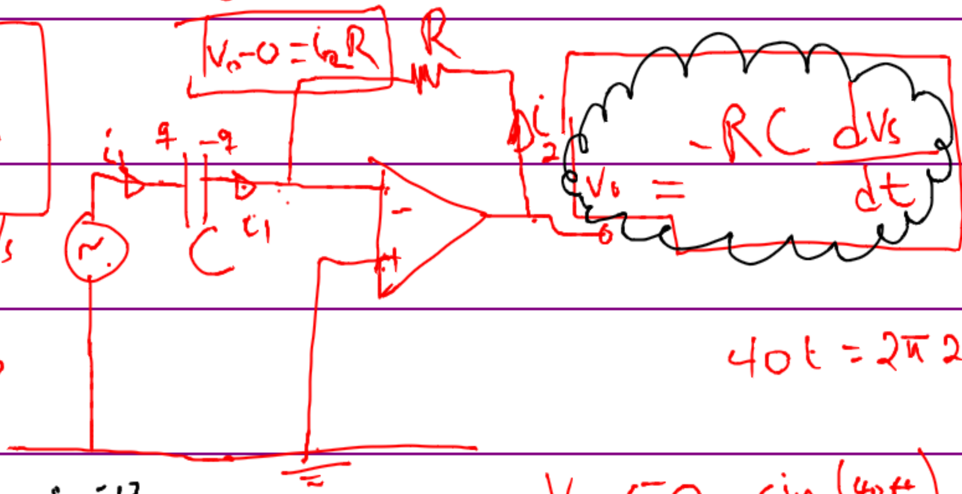




$V_s = 4t$ $\quad \frac{dV_s}{dt} = 4$ $\quad V_o = -1 * 4 = -4$

$C\frac{d(V_s - 0)}{dt} = i_1$

$V_o - 0 = i_2 R$



$V_o = -RC\frac{dV_s}{dt}$

KCL

$i_1 + i_2 = 0$

$i_2 = -i_1$

$i_+ = i_- = 0$

$v_+ = v_-$

$R = 100k\Omega$

$C = 10\mu F$

$40t = 2\pi 20t$

$V_s = 50 \sin\left(\frac{40t}{\pi}\right)$ mV

$V_s(t) = 50\sin(2\pi 20t)$ mV

$f = 20$ Hz

$\Omega F = s$

$RC = 100 * 10^3 * 10 * 10^{-6} = 1s$

$\frac{dV_s}{dt} = 50 * 40\pi \cos(2\pi 20t)$ mV/s

$V_o = -1 s\ 2000\pi \cos(40\pi t)$ mV/s

$= -2000\pi\cos(40\pi t)$

$V_{high} \longrightarrow V_{low}$

$V \equiv V_+ - V_- > 0$

$C = \frac{q}{\ }$

$$C = V$$

$$\frac{d}{dt} CV = \frac{dq}{dt}$$

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