More on Op Amps

Thursday, October 17, 2024 8:20 AM

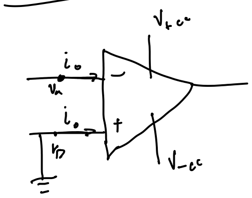
Rule 1 on op amps

The ideal input currents are zero

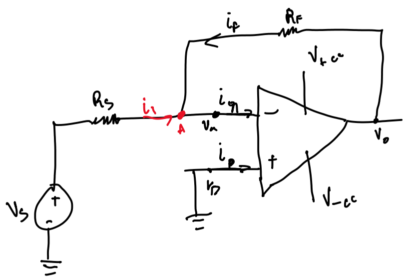
Rule 2

$v_n = v_p$

Inverting Op Amps



-> The gain of the inverting terminal is dictated by the voltage supply



KCL @ A

$i_s + i_f - i_n = 0$

But $i_n = 0$

$i_s + i_f = 0$

$i_s = \frac{V_s - V_n}{R_s}$

$i_f = \frac{V_o - V_n}{R_f}$

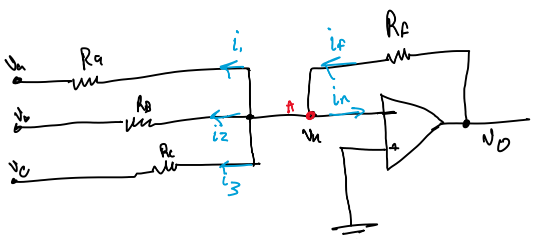
$\frac{V_s - V_n}{R_s} + \frac{V_o - V_n}{R_f} = 0$

we know that $v_n = 0 = v_p$

$\frac{V_s}{R_s} + \frac{V_o}{R_f} = 0$

$\Rightarrow V_o = \left[-\frac{R_f}{R_s}\right] V_s$

Summing Op Amps



KCL @ A

$i_a + i_b + i_c + \cancel{i_n}^{\,0} - i_f = 0$

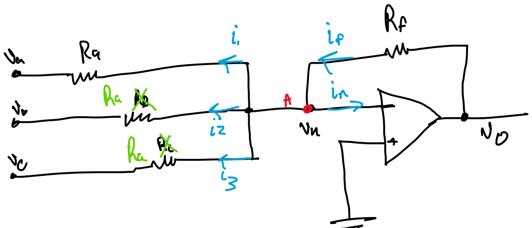
$\frac{V_n - V_a}{R_a} + \frac{V_n - V_b}{R_b} + \frac{V_n - V_c}{R_c} - \left(\frac{V_o - V_n}{R_f}\right) = 0$

$-\frac{V_a}{R_a} - \frac{V_b}{R_B} - \frac{V_c}{R_c} - \frac{V_o}{R_f} = 0$

$$\boxed{V_o = -\left(\frac{+V_a}{R_a} + \frac{V_b}{R_b} + \frac{V_c}{R_c}\right) \cdot R_f}$$

Generic eqn..

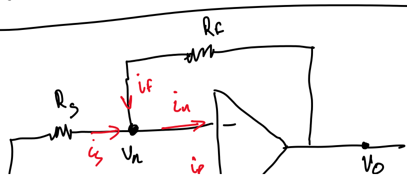
?



$V_o = -\frac{R_f}{R_A}(V_a + V_b + V_c)$

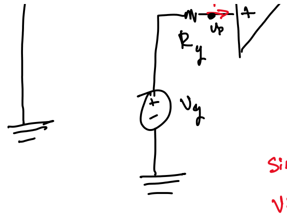
∴ Summing voltages + amplifying it via some constant $\frac{R_f}{R_a}$ w/ reverse polarity.

Non Inverting Amplifier



KCL @ V_n

$i_s - \cancel{i_n}^{\,0} + i_f = 0$



$i_s + i_f = 0$

$$\frac{0 - V_n}{R_s} + \frac{V_o - V_n}{R_f} = 0$$

Since i_p is zero
$V_p = V_g$ due to no current drop across the R_g resistor

$$\frac{-V_n}{R_s} + \frac{V_o - V_n}{R_f} = 0$$

$$\frac{-V_g}{R_s} + \frac{V_o - V_g}{R_f} = 0$$

$$\frac{-V_g}{R_s} + \frac{V_o}{R_f} - \frac{V_g}{R_f} = 0$$

$$\frac{V_g}{R_s} = \frac{V_o}{R_f} - \frac{V_g}{R_f}$$

$$\frac{V_o}{R_f} = \frac{V_g}{R_s} + \frac{V_g}{R_f}$$

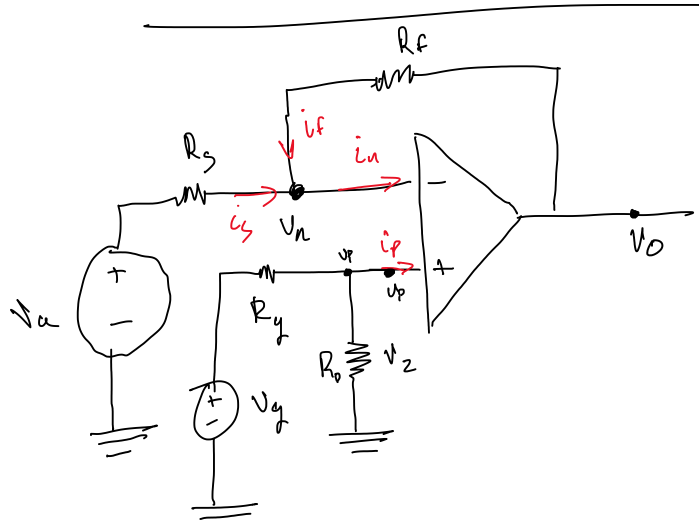
$$V_o = R_f\left[\frac{1}{R_s} + \frac{1}{R_f}\right] V_g$$

$$\boxed{V_o = \left[1 + \frac{R_f}{R_s}\right] \cdot V_g}$$

Non-inverting as the output repairs same polarity as input.

2

Differential Amplifier



KCL @ V_n

$i_s + i_f - \cancel{i_n}^{0} = 0$

$$\frac{V_a - V_n}{R_s} + \frac{V_o - V_n}{R_f} = 0$$

w.k.t. $V_n = V_p$

and w/ voltage divider

$$v_n = v_p = V_g\left(\frac{R_o}{R_o + R_g}\right)$$

$$\frac{V_a - V_g\left(\frac{R_o}{R_o+R_g}\right)}{R_s} + \frac{V_o - V_g\left(\frac{R_o}{R_o+R_g}\right)}{R_f} = 0$$

x eqn is wrong 2

$$\Rightarrow \boxed{v_o = \left[\frac{R_o(R_s + R_g)}{R_s(R_c + R_o)}\right] v_g - \left[\frac{R_g}{R_s}\right] v_a = 0}$$