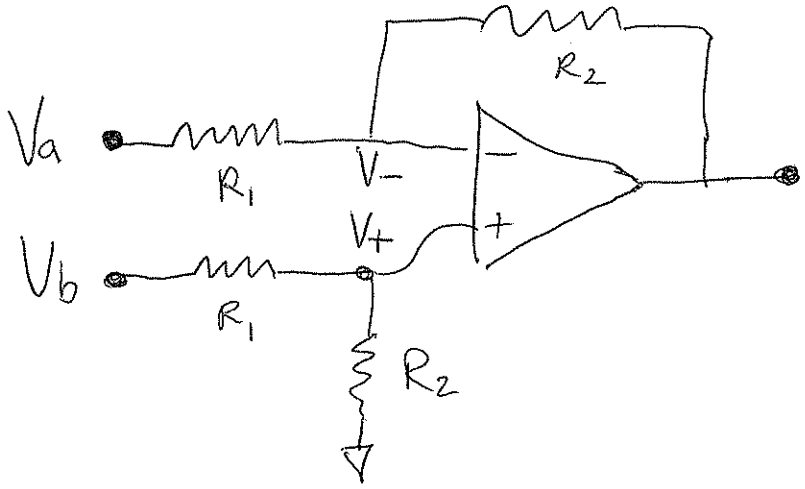
Difference Amplifier :



$$V_{out} = \frac{R_2}{R_1}(V_b - V_a)$$

Calculate V_{out} using first principles.

Non-inverting input :

(Divider) $$V_+ = \left(\frac{R_2}{R_1+R_2}\right) V_b = f V_b \quad (1)$$

Inverting input :

($\vec{I}$ conservation) $$\frac{V_a - V_-}{R_1} = \frac{V_- - V_{out}}{R_2} \quad (2)$$

(Solve for V_-)

$$V_-\left(\frac{1}{R_1}+\frac{1}{R_2}\right) = \frac{V_a}{R_1} + \frac{V_{out}}{R_2}$$

$$V_-\left(\frac{R_1+R_2}{R_1R_2}\right) = \frac{V_a}{R_1} + \frac{V_{out}}{R_2}$$

$$V_-(R_1+R_2) = R_2 V_a + R_1 V_{out}$$

$$V_- = \underbrace{\left(\frac{R_2}{R_1+R_2}\right)}_{=f} V_a + \underbrace{\left(\frac{R_1}{R_1+R_2}\right)}_{=f\frac{R_1}{R_2}} V_{out}$$

$$V_- = f V_a + f\frac{R_1}{R_2} V_{out} \quad (3)$$

Op-amp output:

$V_+ = (1)$

$V_- = (3)$

$$V_{out} = G(V_+ - V_-)$$

$$V_{out} = G\left(fV_b - fV_a - f\frac{R_1}{R_2} V_{out}\right)$$

$$V_{out} = Gf\left(V_b - V_a - \frac{R_1}{R_2} V_{out}\right)$$

$$V_{out}\left(1 + Gf\frac{R_1}{R_2}\right) = Gf(V_b - V_a)$$

Assuming $Gf\frac{R_1}{R_2} \gg 1 \Rightarrow \left(1 + Gf\frac{R_1}{R_2}\right) \cong Gf\frac{R_1}{R_2}$

$$\boxed{V_{out} \cong \frac{R_2}{R_1}(V_b - V_a)} \quad (2)$$