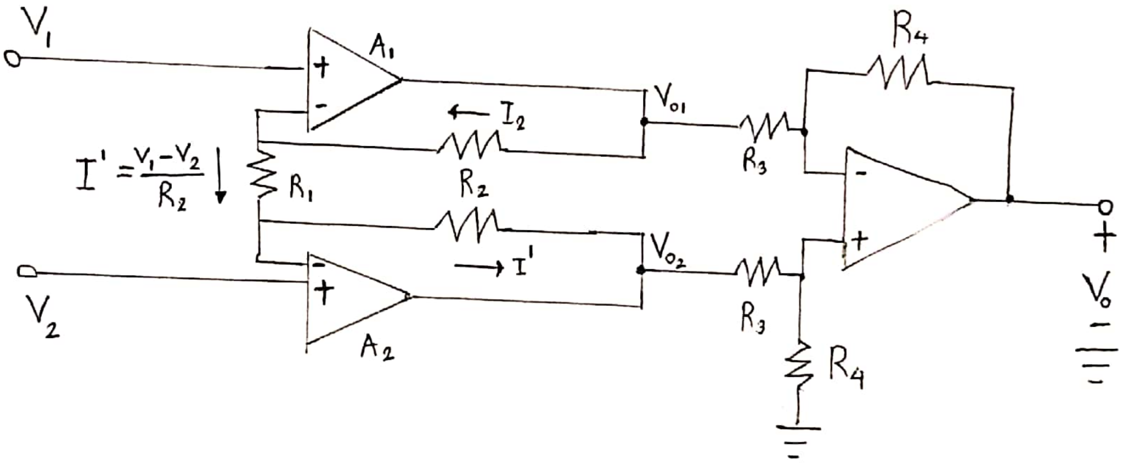
Instrumental Amplification

Name - Md Farhan Ishmam
Dept - Computer Science and Engineering
Section - CSE A
ID: - 180041120
Date - 13-October-2020



The given diagram shows the circuit design of an instrumental amplifier.

A_1 is an inverting amplifier

A_2 is a non-inverting amplifier.

A_3 is a difference amplifier.

For the difference amplifier, A_3

$$V_o = V_{o_1} - V_{o_2}$$

$$V_{o_1} = \frac{V_1 - V_2}{R_1} \times R_2 + V$$

$$V_{o_2} = V_2 - \frac{V - V_2}{R_1} R_2$$

$$= \frac{(V_1 - V_2)}{R_1} R_2 + (V_1 - V_2) + \frac{(V_1 - V_2)}{R_1} R_2$$

$$= (V_1 - V_2)\left(\frac{R_2}{R_1} + 1 + \frac{R_2}{R_1}\right)$$

$$= (V_1 - V_2)\left(1 + \frac{2R_2}{R_1}\right)$$

For the inverting amplifier, A_1,

$$V_{out} = -\frac{R_f}{R_{in}} \times V_{in}$$

$$\Rightarrow V_{oi} = -V_{o1}\left[\frac{R_4}{R_3}\right]$$

For non-inverting amplifier, A_2,

$$V_{out} = V_{in}\left(\frac{R_{in} + R_f}{R_{in}}\right)$$

$$\Rightarrow V_{on} = V_{o2}\left[\frac{R_4}{R_3 + R_4}\right]\left[1 + \frac{R_4}{R_3}\right]$$

So, difference amplifier, A_3 [sum of outputs produced by each input]

$$V_{out} = V_{oi} + V_{on} = V_{o2}\left[\frac{R_4}{R_3 + R_4}\right]\left[1 + \frac{R_4}{R_3}\right] - V_{o1}\left[\frac{R_4}{R_3}\right]$$

$$= V_{o2}\left[\frac{R_4}{R_3 + R_4}\right]\left[\frac{R_3}{R_3} + \frac{R_4}{R_3}\right] - V_{o1}\left[\frac{R_4}{R_3}\right]$$

$$= V_{o2}\left[\frac{R_4}{R_3 + R_4}\right]\left[\frac{R_3 + R_4}{R_3}\right] - V_{o1}\left[\frac{R_4}{R_3}\right]$$

$$= V_{o2}\left[\frac{R_4}{R_3}\right] - V_{o1}\left[\frac{R_4}{R_3}\right]$$

$$= \left(V_{o2} - V_{o1}\right)\left[\frac{R_4}{R_3}\right]$$

$$= -\left(V_1 - V_2\right)\left[1 + \frac{R_2}{R_1}\right]\left[\frac{R_4}{R_3}\right]$$

$$= \left(V_2 - V_1\right)\left[1 + \frac{R_2}{R_1}\right] \times \left[\frac{R_4}{R_3}\right]$$

For $R_2 = R_3 = R_4$

$$V_{out} = \left(V_2 - V_1\right)\left[1 + \cancel{\frac{R_2}{R_1}}\ \frac{R_2}{R_1}\right]$$