Topic: INSTRUMENTATION AMPLIFIER

B.G. Sem-III

In a differential amplifier, the output is directly proportional to the difference, V_d between two input voltages V_1 and V_2. i.e

$$V_0 = \frac{R_2}{R_1}(V_2 - V_1) = \frac{R_2}{R_1} V_d \longrightarrow (1)$$

Fig (1) shows a differential amplifier. The main weaknesses of this amplifier are given below —

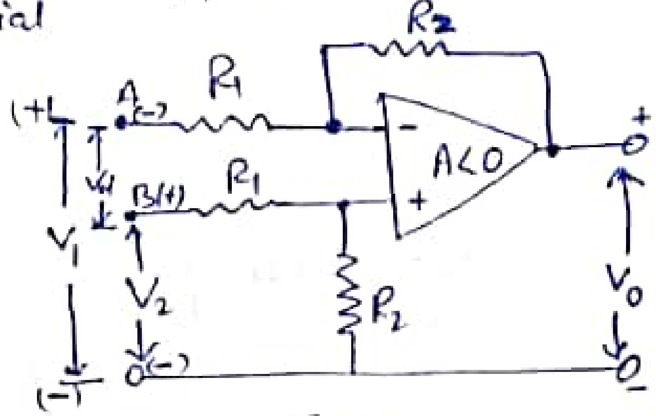

Fig (1)

(i) By placing input and feedback resistors on the OP-AMP, the impedance of the circuit is lowered. It can Cause loading effects.

(ii) In order to change the gain, it is now necessary to vary two resistors.

Both these weakness are overcome in "**instrumental amplifier**". The diagram of an instrumental amplifier is shown in fig (2). It consists of three op-AMPs. The first two op-AMPs A_1 and A_2 provide a high input impedances because the signals go directly into the noninverting inputs of the OP-AMPs. The third amplifier A_3 represents the usual differential amplifier like in fig (1).

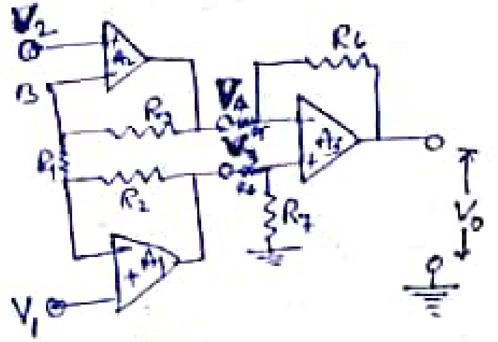

Fig (2)

Now using eq^n (1) if we choose $R_6 = R_7$ and $R_5 = R_4$ in fig (2), we get

$$V_0 = \frac{R_7}{R_4}(V_3 - V_4) \longrightarrow (2)$$

We know that voltage at terminal A i.e V_A must equal to V_1 and V_B must equal to V_2. Also resistor R_1, R_2 and R_3 are in series and hence same current flows through them.

$$\text{i.e } I = \frac{V_1 - V_2}{R_1} = \frac{V_3 - V_1}{R_2} = \frac{V_2 - V_4}{R_3} \rightarrow (3)$$

Thus we have two more equations

$$\frac{V_1 - V_2}{R_1} = \frac{V_3 - V_1}{R_2} \longrightarrow (4)$$

and

$$\frac{V_1 - V_2}{R_1} = \frac{V_2 - V_4}{R_3} \longrightarrow (5)$$

From eq^n (4), we get

$$V_3 - V_1 = \frac{R_2}{R_1}(V_1 - V_2)$$

$$\therefore V_3 = \frac{R_2}{R_1}(V_1 - V_2) + V_1 \longrightarrow (6)$$

Again from eq^n (5), we obtain

$$V_4 - V_2 = -\frac{R_3}{R_1}(V_1 - V_2)$$

$$\therefore V_4 = \frac{R_3}{R_1}(V_2 - V_1) + V_2 \longrightarrow (7)$$

So that, on letting $R_3 = R_2$, we have

$$(V_3 - V_4) = (V_1 - V_2)\left[\frac{R_2}{R_1} + \frac{R_2}{R_1} + 1\right]$$

$$= (V_1 - V_2)\left[1 + \frac{2R_2}{R_1}\right] \longrightarrow (8)$$

Putting this value in eq^n (2), we have

$$V_0 = \frac{R_7}{R_4}(V_1 - V_2)\left[1 + \frac{2R_2}{R_1}\right]$$

∴ voltage gain of this amplifier will

$$A_v = \frac{V_0}{V_1 - V_2} = \frac{R_7}{R_4}\left[1 + \frac{2R_2}{R_1}\right] = \left(1 + \frac{2R_2}{R_1}\right)$$

as $R_4 \simeq R_7$.

Thus the gain of instrumentation amplifier c changed by simply changing a single resi R_1.