- Operational Amplifier
- Basic op-Amp (Operation of OP-AMP as a constant gain multiplier)
- Applications of op-AMP

— Numericals related to op-Amp

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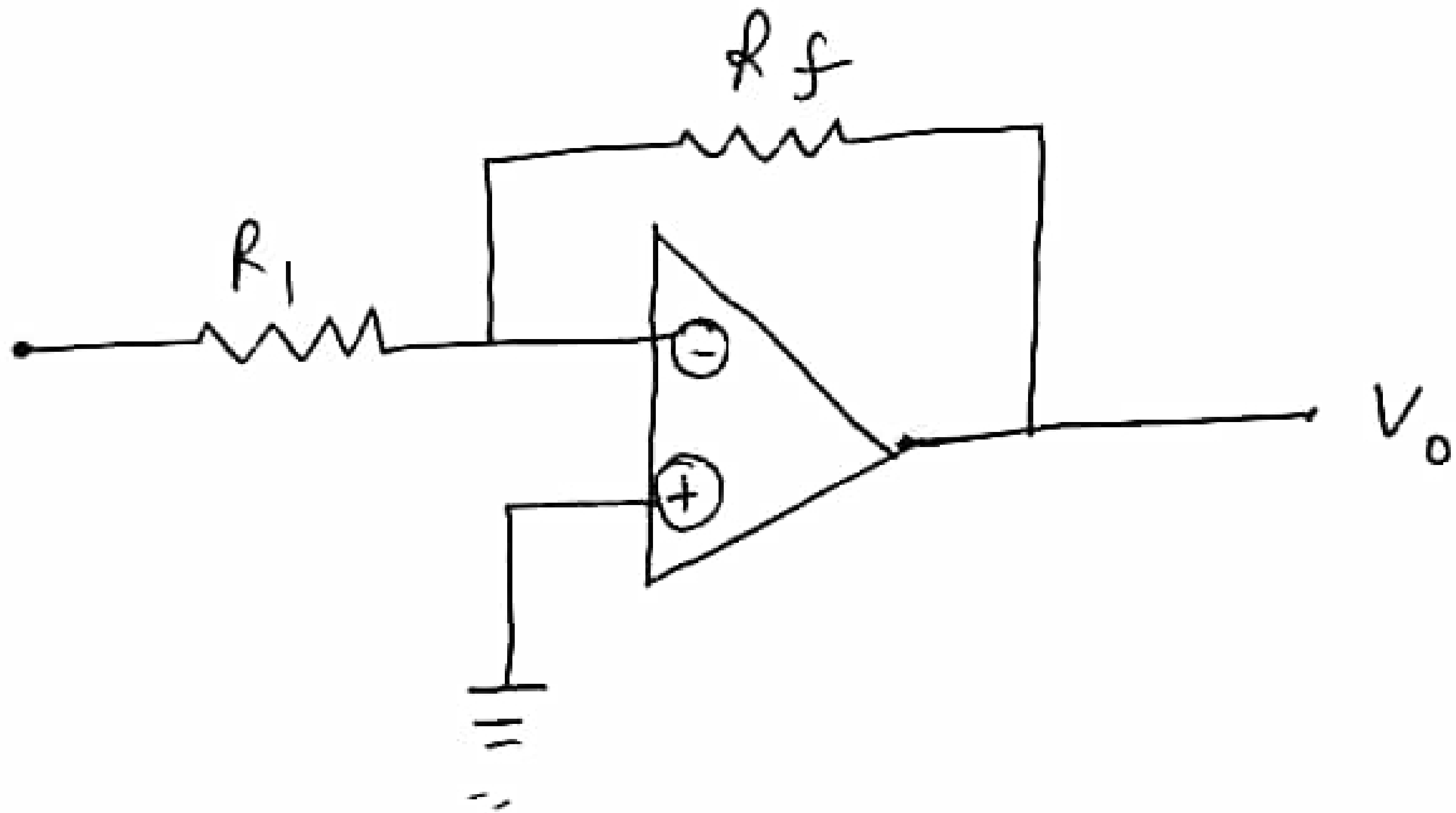
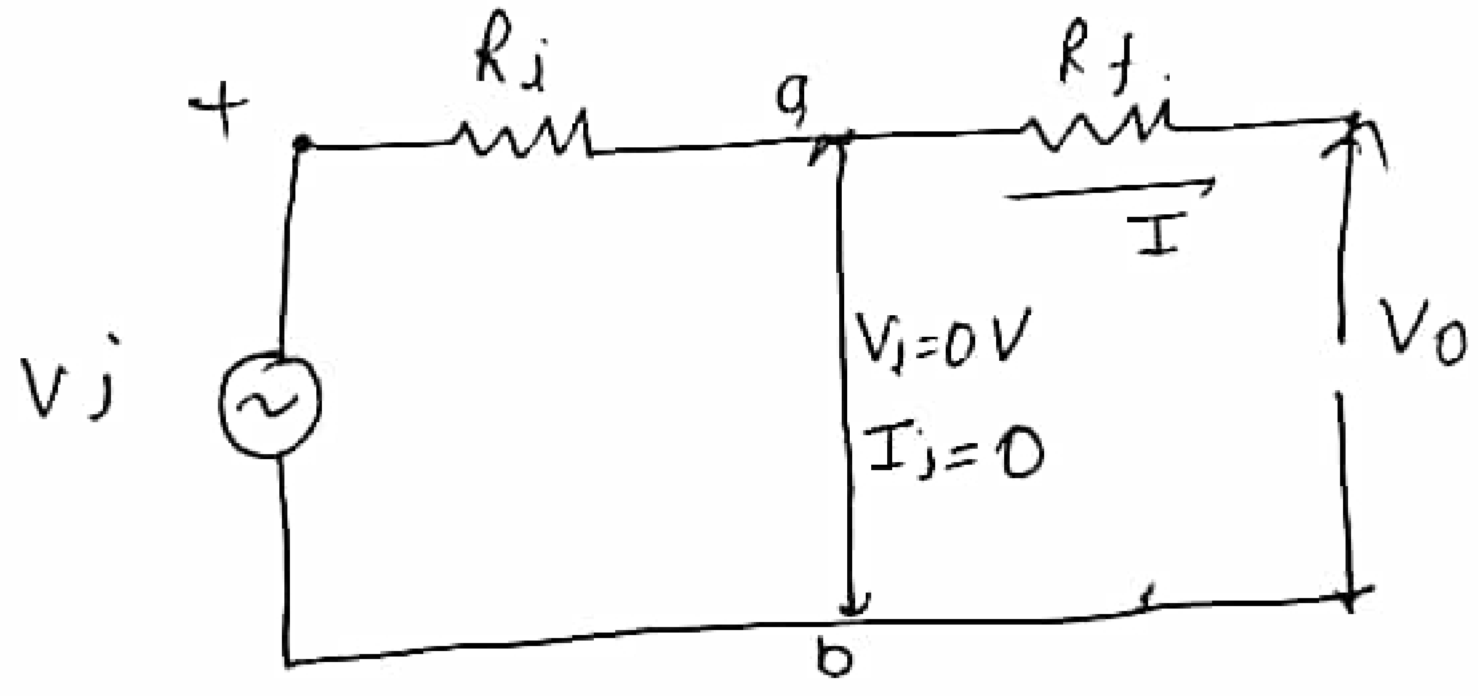
Basic OP-AMP (Operation of OP-AMP as a constant gain multiplier)



Voltage gain $\left(\frac{V_o}{V_1}\right) = -\frac{R_f}{R_1}$

Virtual ground :-

The concept of virtual ground implies that although the input voltage is about 0V, there is no current through the input of the amplifier to the ground.



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The line across a and b indicates that a short exist $V_i = 0V$. But the virtual short is that no current passes through the short to the ground.

$$\therefore \boxed{\frac{V_o}{V_i} = -\frac{R_f}{R_1}}$$

* The concept of virtual ground helps us to determine the overall voltage gain in a simple manner.

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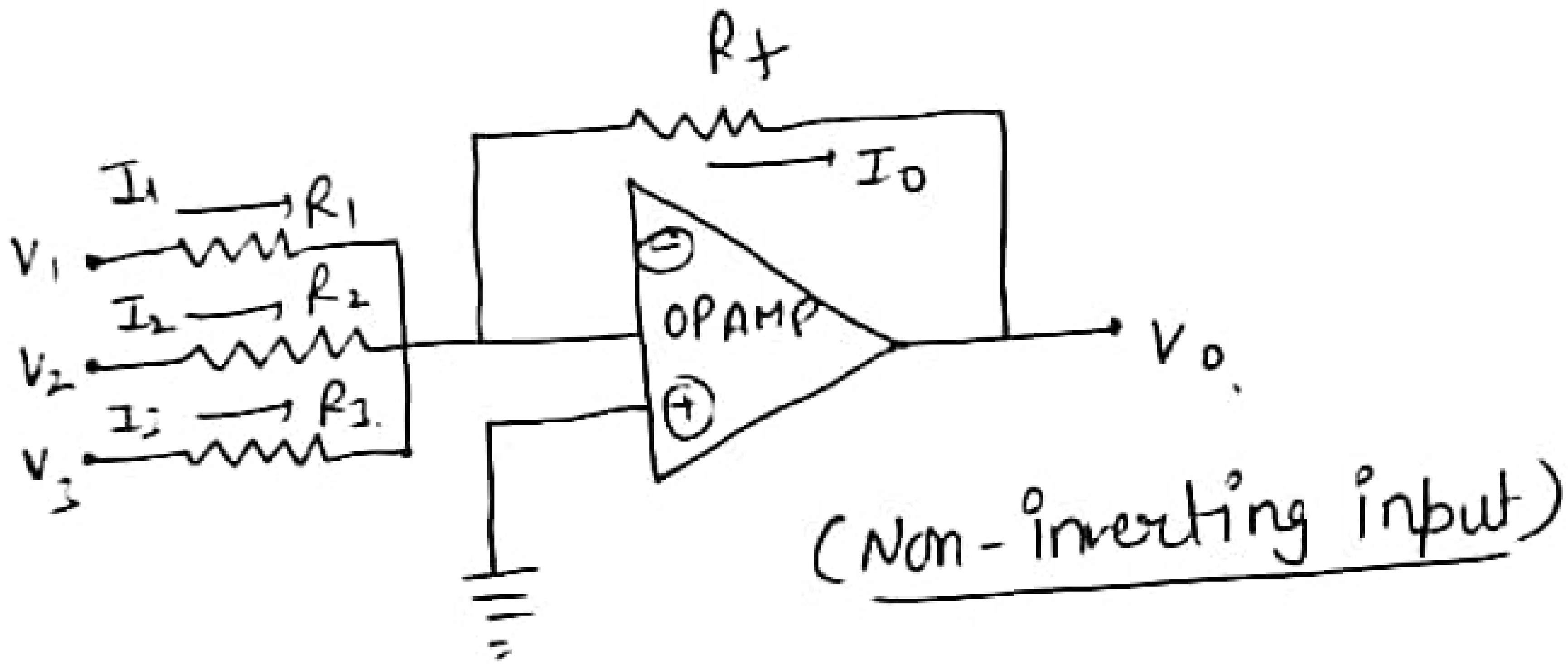
Applications of OP-AMP

1. Adder or Summing Amplifier.
2. OP-AMP Subtractor
3. Inverting Amplifier
4. Non-inverting amplifier
5. OP-AMP Integrator
6. OP-AMP Differentiator.

(9) Adder or Summing Amplifier.



According to Kirchoff's current law.

$$I_1 + I_2 + I_3 = I_0$$

or $$\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} = \frac{-V_0}{R_f}$$

$$V_o = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$$

If $R_1 = R_2 = R_3 = R$,

then $$V_o = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$$

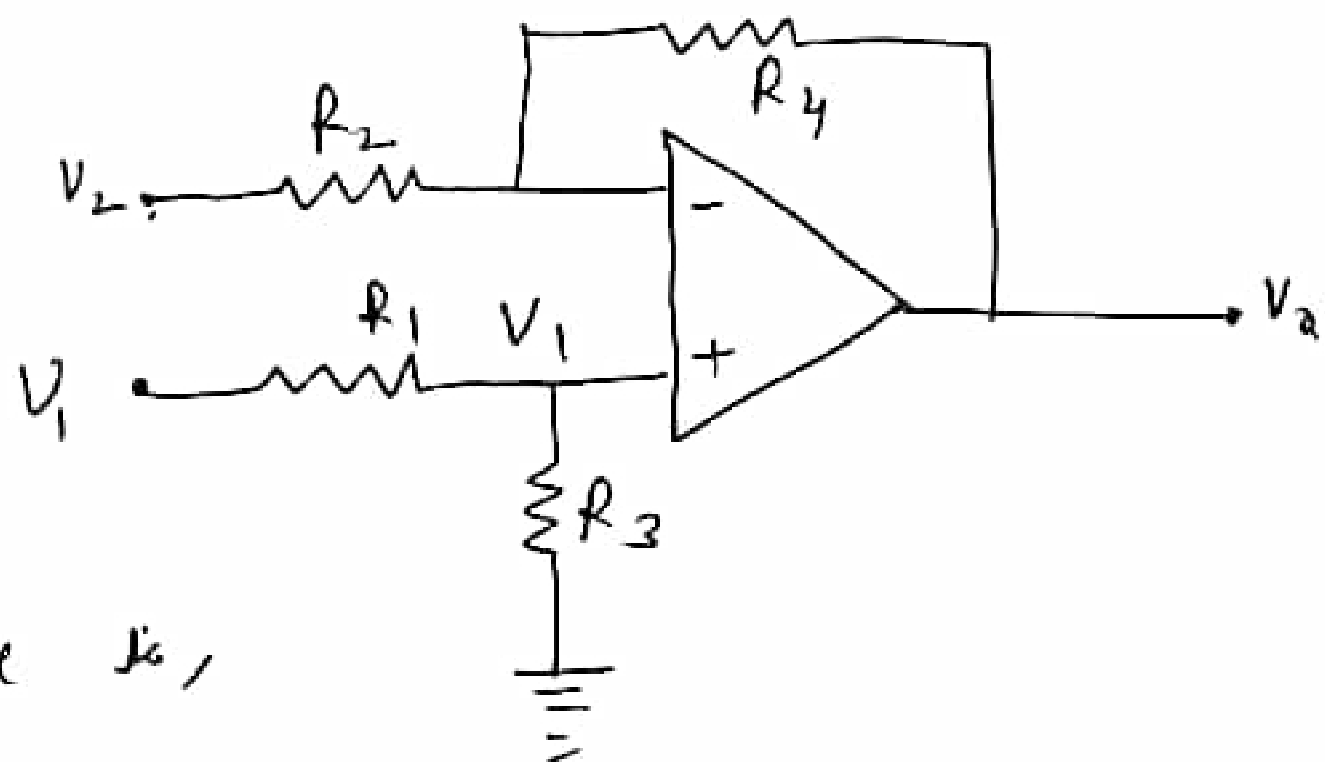
$$= -\frac{R_f}{R}(V_1 + V_2 + V_3)$$

If $\boxed{R_f = R}$

$$\boxed{V_o = -(V_1 + V_2 + V_3)}$$

* Negative sign shows that the output voltage is out of phase with the sum of input voltages.

② OP-AMP Subtractor



Output voltage is,

$$V_0 = \left(\frac{R_3}{R_1+R_2}\right)\left(\frac{R_2+R_4}{R_2}\right)V_1 - \frac{R_4}{R_2}V_2$$

If $R_1 = R_2 = R_3 = R_4 = R$

$$V_0 = \left(\frac{R}{2R}\right)\left(\frac{2R}{R}\right)V_1 - \frac{R}{R}V_2$$

$$\Rightarrow \boxed{V_0 = V_1 - V_2}$$

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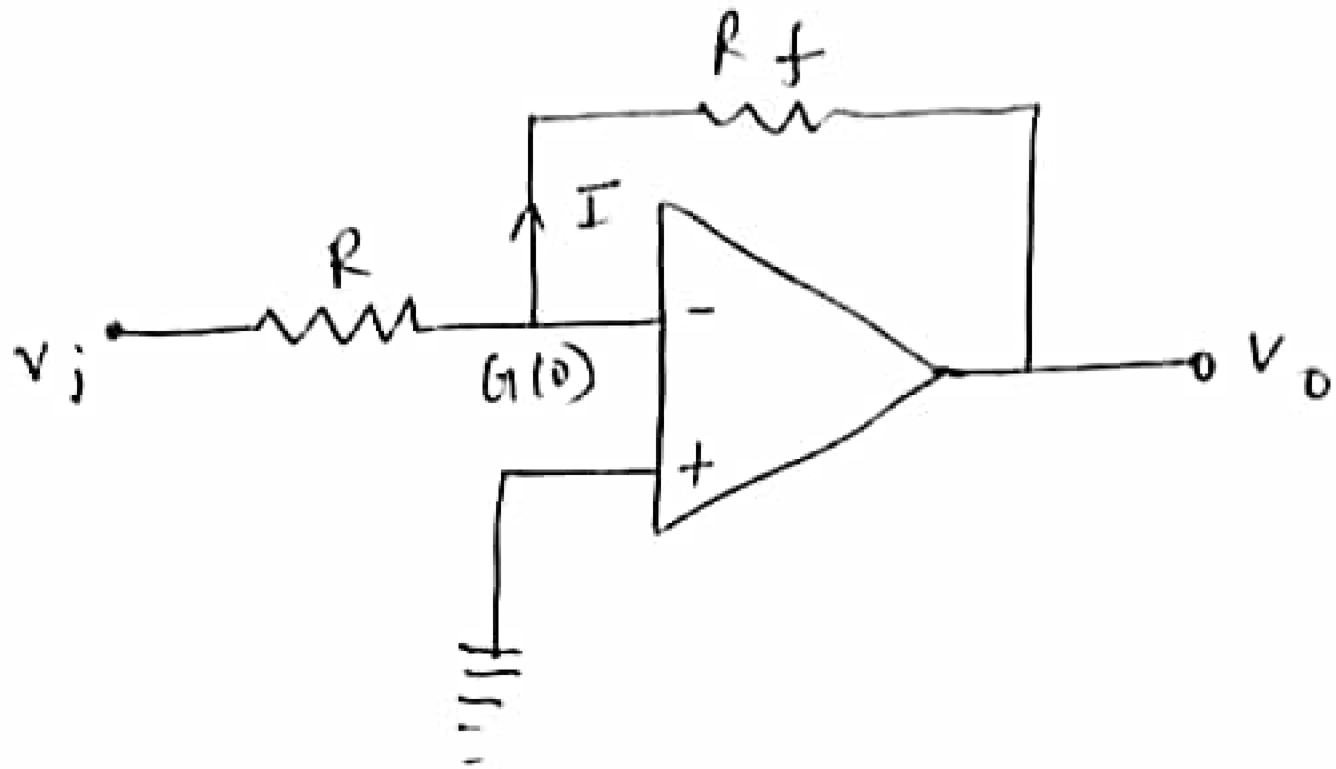
③ Inverting Amplifier



Since point G is practically grounded,
so potential at G = 0

$$I = \frac{V_i - 0}{R} = \frac{V_i}{R}$$

Acc. to Kirchoff's current law

$$\frac{V_i}{R} = \frac{0 - V_0}{R_f}$$

$$\frac{V_i}{R} = \frac{-V_0}{R_f}$$

$$\boxed{\frac{V_0}{V_i} = -\frac{R_f}{R}}$$

$\frac{V_0}{V_i} = A_V$ = Voltage gain of the amplifier

So, $\boxed{A_V = -\frac{R_f}{R}}$

−ve sign shows → Phase difference between output voltage & input voltage is 180°

Output voltage − inverted w.r.t. to input voltage.

Thank You