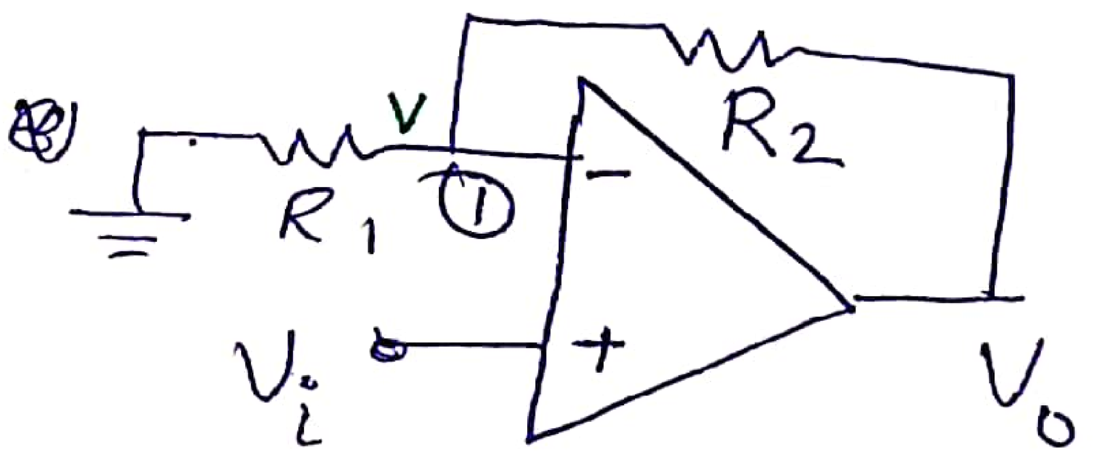
Non-inverting Amplifier Configuration:

(Input is applied at non-inv input terminal)



Writing nodal eqn at ①, Let the voltage at node-① be v

$$v\left(\frac{1}{R_1}+\frac{1}{R_2}\right) = 0\times\frac{1}{R_1} + V_o\times\frac{1}{R_2}$$

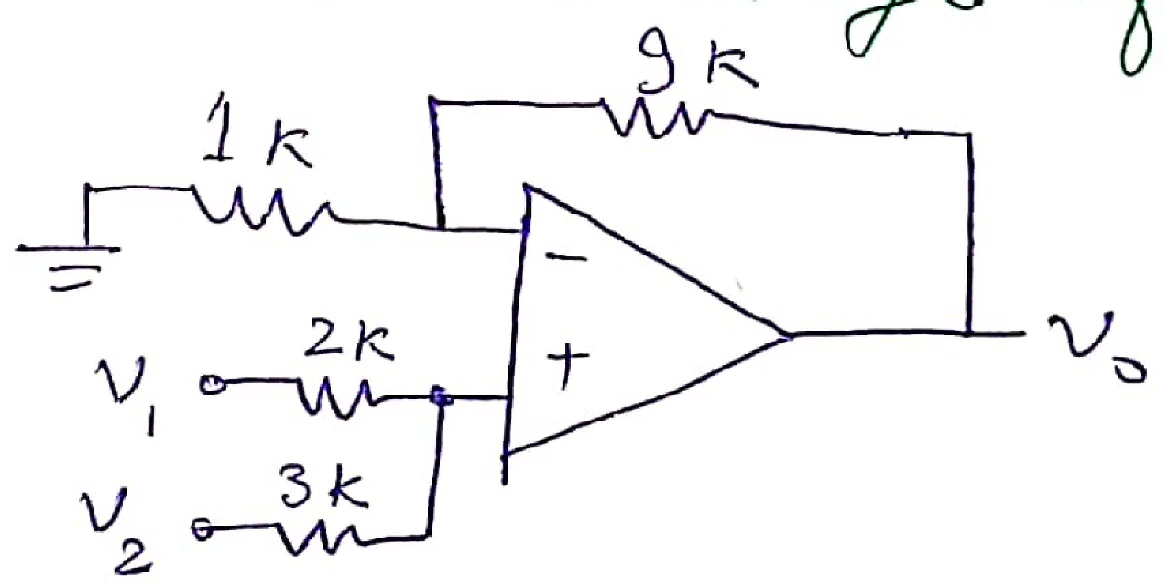
But due to V.S.C., $v = v_i$

$$v_i\left(\frac{1}{R_1}+\frac{1}{R_2}\right) = \frac{V_o}{R_2}$$

or,

$$\boxed{V_o = \left(1+\frac{R_2}{R_1}\right)v_i} \quad -(1)$$

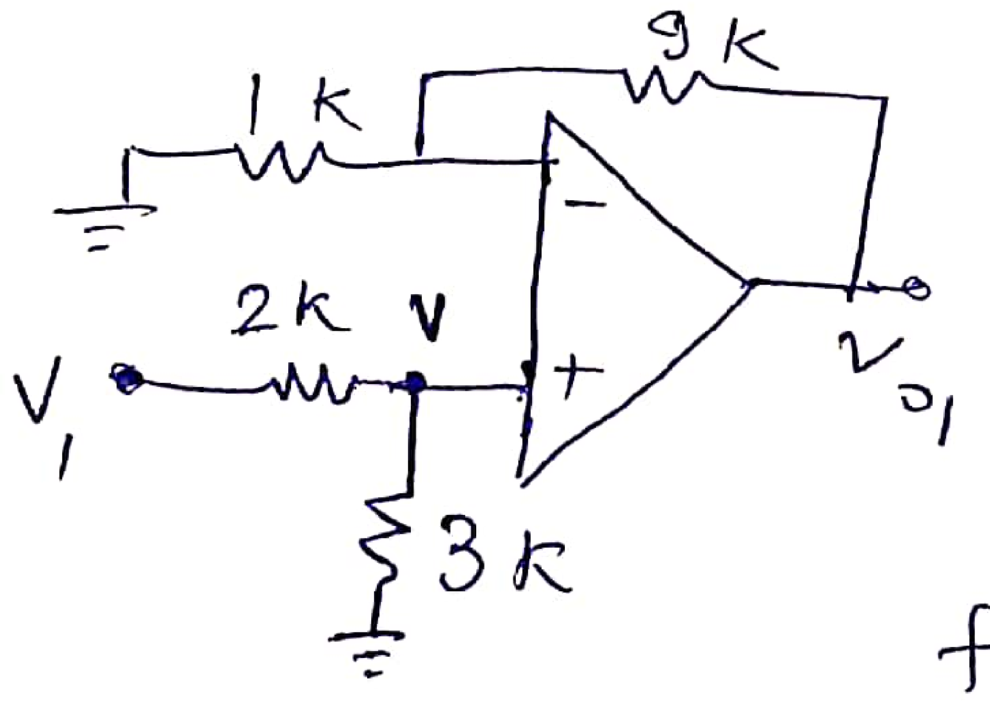
Example Find the output voltage of the shown circuit



(1) Using superposition principle

V_1 & V_2 applied individually one at a time

Only $\underline{\underline{V_1}}$

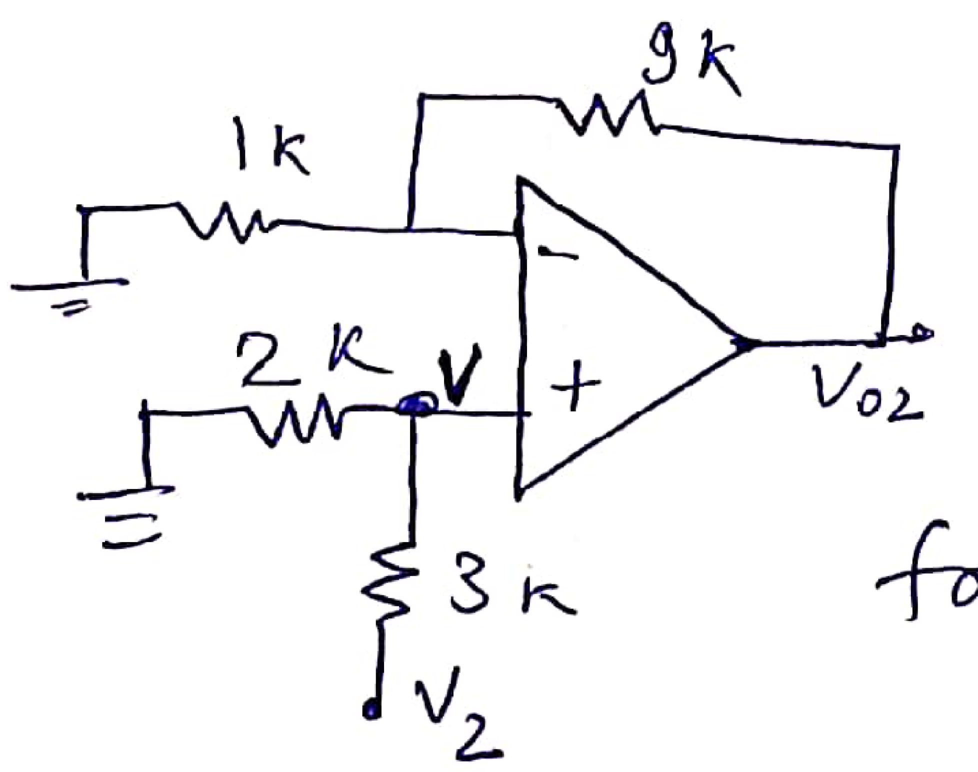


using voltage divider rule, $V = \frac{3}{2+3}V_1$

$V = 3/5\, V_1$

from (1), $V_{o_1} = \left(1+\frac{9K}{1K}\right)V = 10\times\frac{3}{5}V_1 = 6V_1$

Only $\underline{\underline{V_2}}$



using voltage divider rule, $V = \frac{2}{2+3}V_2 = \frac{2}{5}V_2$

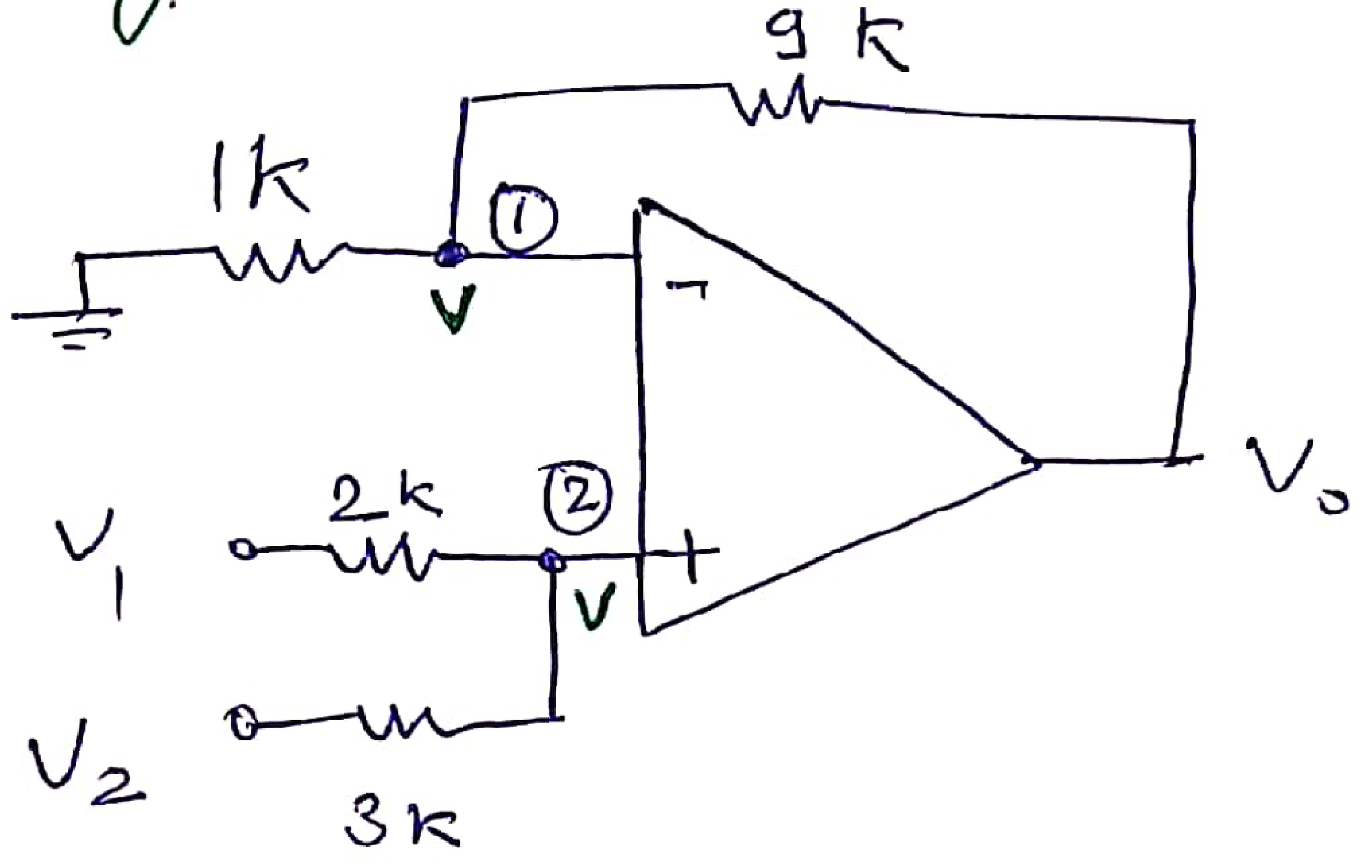
from (1), $V_{o_2} = \left(1+\frac{9K}{1K}\right)V = 10\times\frac{2}{5}V_2 = 4V_2$

The overall output voltage

$$v_o = V_{o1} + V_{o2}$$

$$\boxed{v_o = 6V_1 + 4V_2}$$

(II) Using Nodal eqn.



due to V.S.C, the voltages at both nodes ① & ② are same, Assume it to be v

Nodal eqn at ①

$$v\left(1 + \frac{1}{9}\right) = \frac{v_o}{9}$$

$$\cancel{v_o = 10}$$

$$10v = v_o \quad \text{——— (1)}$$

Nodal eqn at ②

$$v\left(\frac{1}{2} + \frac{1}{3}\right) = \frac{V_1}{2} + \frac{V_2}{3}$$

$$\frac{5}{6}v = \frac{V_1}{2} + \frac{V_2}{3} \quad \text{——— (2)}$$

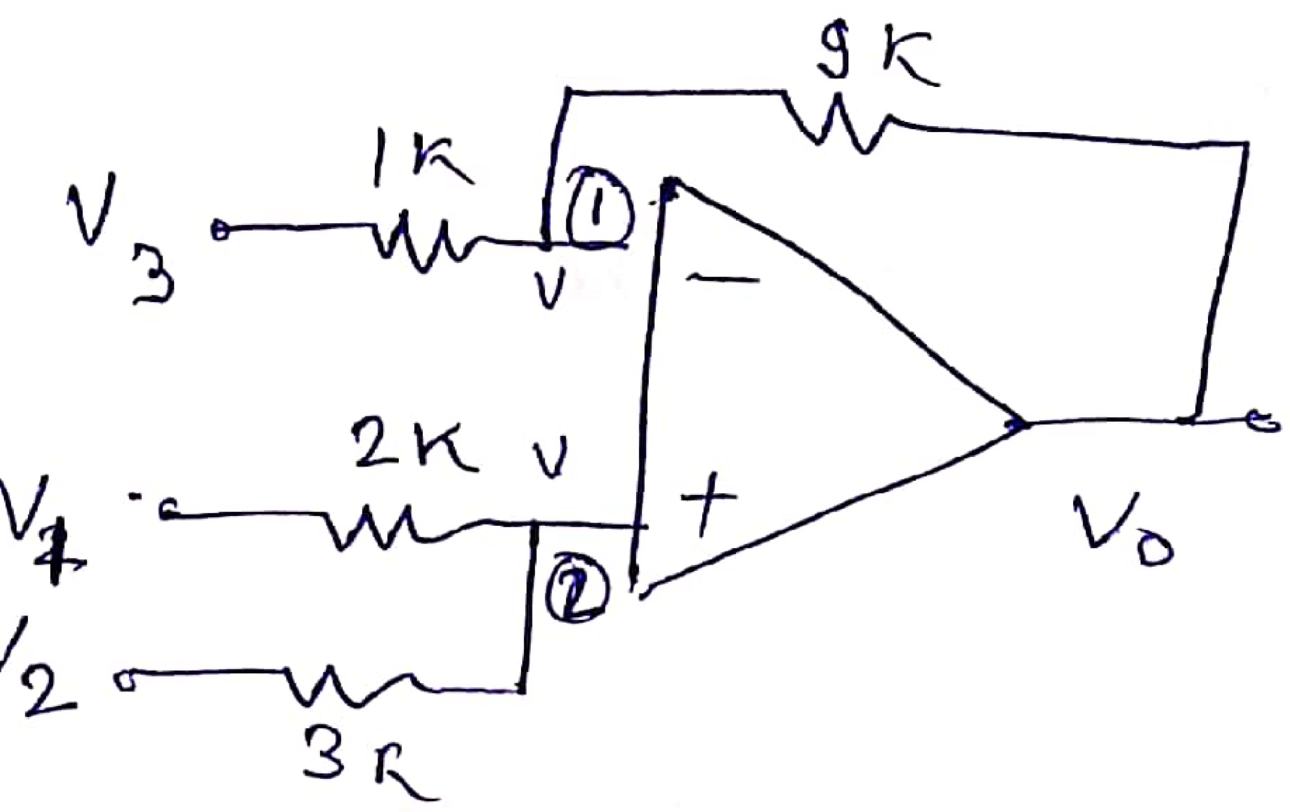
Dividing (1) by (2),

$$\frac{10\cancel{v}}{5/6\,\cancel{v}} = \frac{V_o}{\frac{V_1}{2} + \frac{V_2}{3}}$$

$$\Rightarrow \quad V_o = 12\left(\frac{V_1}{2} + \frac{V_2}{3}\right)$$

$$\boxed{V_o = 6V_1 + 4V_2}$$

Ex In the prev. example, determine V_o if 1 k resistor is connected to V_3 instead grounded.



using nodal eqn.

at Node ①,

$$v\left(1+\frac{1}{9}\right) = \frac{V_3}{1} + \frac{V_o}{9}$$

$$10v = 9V_3 + V_o \quad \text{——— (1)}$$

at Node ②, eqn remain the same

$$\frac{5}{6}v = \frac{V_1}{2} + \frac{V_2}{3} \quad \text{——— (2)}$$

Dividing (1) by (2)

$$\frac{10\cancel{v}}{5/6\,\cancel{v}} = \frac{9V_3 + V_o}{\frac{V_1}{2} + \frac{V_2}{3}}$$

$$12\left(\frac{V_1}{2} + \frac{V_2}{3}\right) = 9V_3 + V_o$$

$$\boxed{V_o = 6V_1 + 4V_2 - 9V_3}$$

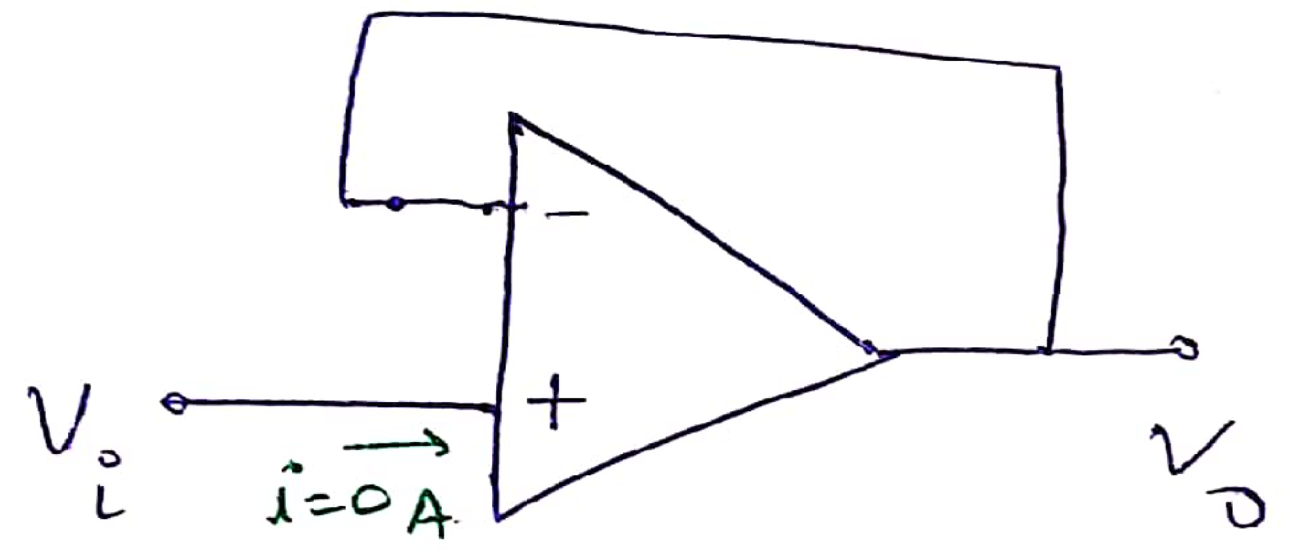
Here we have an important observation. the weighed summer now have a negative weight as we can see.

The we can implement a negative k by applying ~~any~~ any input voltage at non-inverting terminal as in the given example.

Unity-gain Amplifier / Voltage Follower :-

Unity gain amplifier or buffer amplifier is used to connect a source with high impedance to a low impedance load without causing any voltage amplification.

Therefore It does not provide any voltage gain rather, it is mainly used as an impedance transfor-mer.



due to virtual short circuit

$$V_o = V_i$$

$$\boxed{\frac{V_o}{V_i} = 1}$$ Voltage Gain is Unity

Output just follow the input, that is why it is called voltage follower

Input impedance $R_{in} = \infty$

Output impedance $R_{out} = 0$