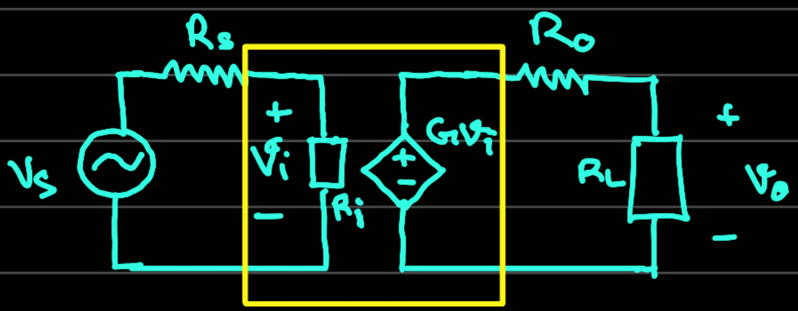
Day-9

→ **Operational Amplifier (OpAmp) :**

☆ Applications –

- Addition, Subtraction, Integrator, different-iator.
- Filter
- To sense voltage, current, pressure, Temp-erature.



$$\frac{v_o}{v_s} < G$$

$$v_o = \frac{R_L}{R_L + R_o} G v_i$$

$$v_i = \frac{R_i}{R_i + R_s} v_s$$

so $$v_o = G \frac{R_L}{R_L + R_o} \times \frac{R_i}{R_i + R_s} v_s$$

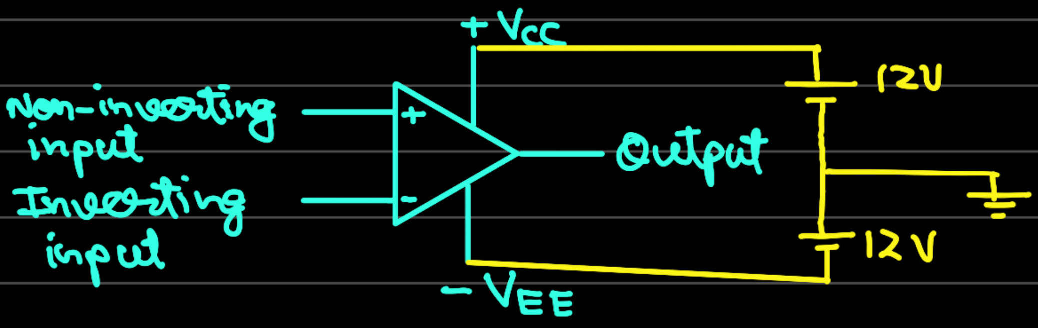
we demand $R_o << R_L$, $R_i >> R_s$

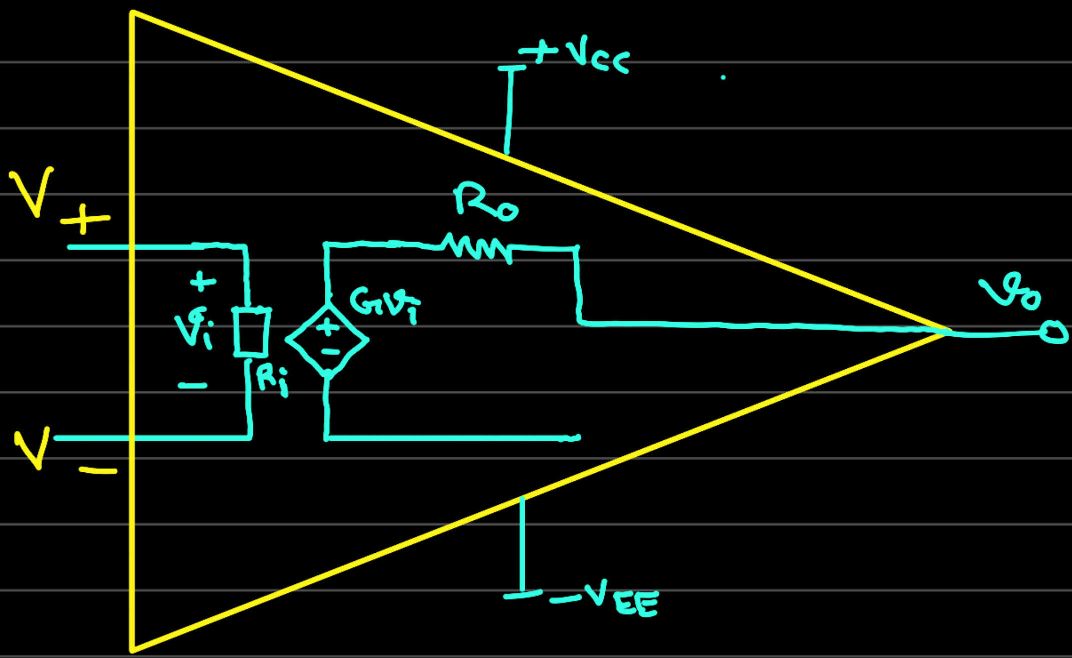
for $v_o = G v_s$

$R_o << R_L$ ↓ low output impedance

$R_i >> R_s$ ↓ High input impedance

→ OpAmp 741 (LM741) :



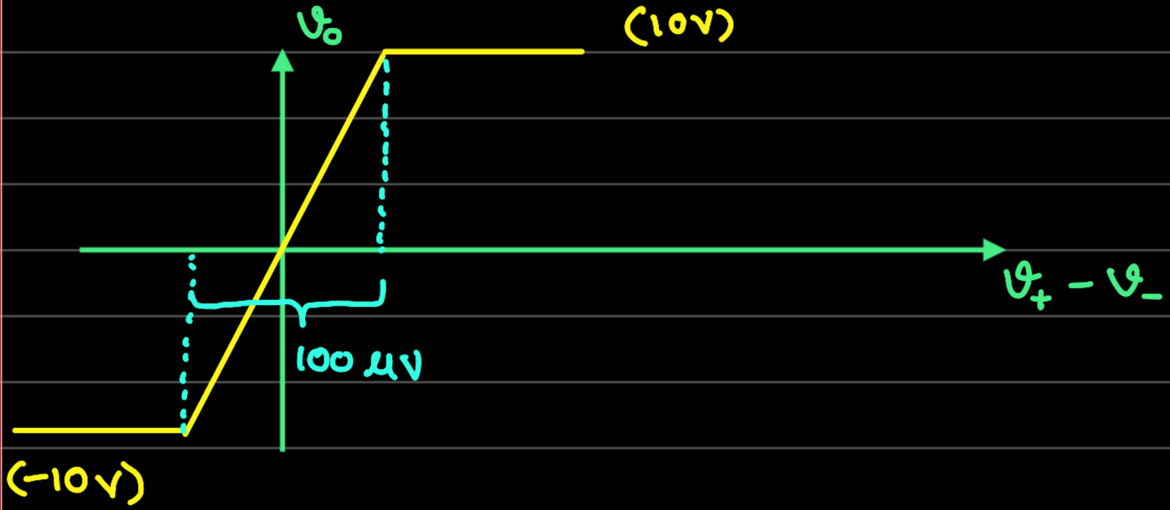


<u>741</u>

$R_i \sim 2\,M\Omega$

$G \sim 2 \times 10^5$

$R_o \sim 75\,\Omega$

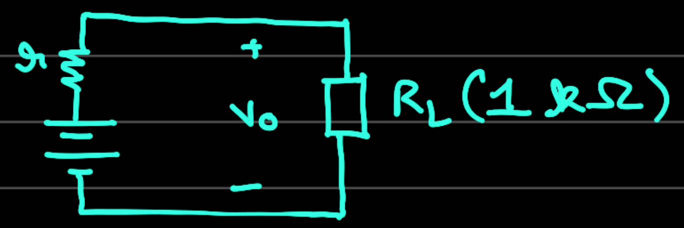


$$I = \frac{10^{-4}}{2 \times 10^{6}}\ A = 5 \times 10^{-11} A \sim 0$$

100 µV ⇝ short but yet no current.
This is called virtual short.

Is this a feature we are looking for?

Eg:



($r = 500\,\Omega$, exaggerated)

$$V_o = \frac{10 \times 1}{1.5}\,V = 6.67\,V$$

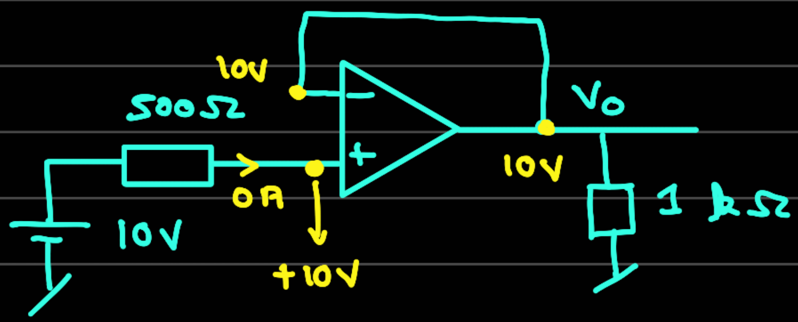
we expected $V_o = 10V$

This is called loading effect.

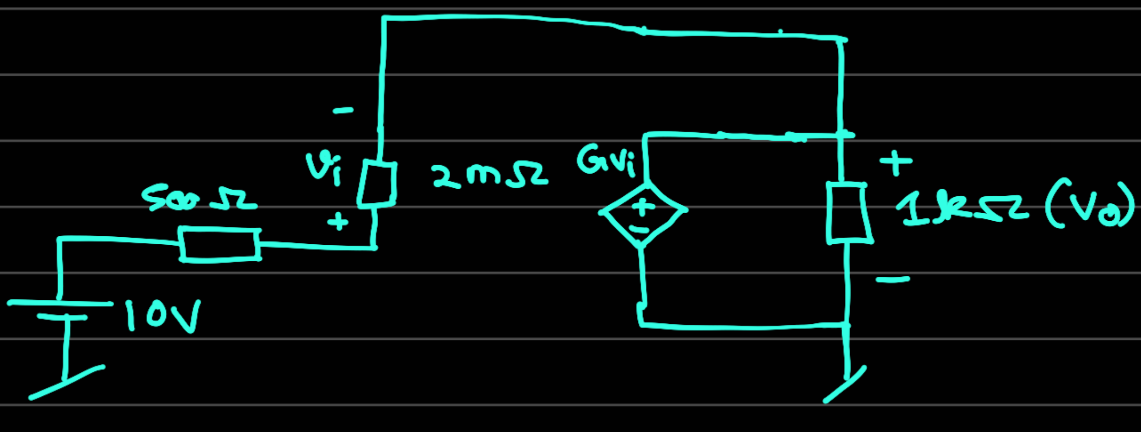
To reduce it,

- Decrease r
- Increase R_L

Eg:



use the concept of virtual short



$$V_o = G\vartheta_i$$

$$\vartheta_s - \vartheta_o = (R_s + R_i)\,\frac{\vartheta_i}{R_i}$$

$$\vartheta_o = G(\vartheta_s - \vartheta_o)\,\frac{R_i}{R_s + R_i}$$

$$\Rightarrow \vartheta_o\left[1 + \frac{1}{G}\,\frac{R_s + R_i}{R_i}\right] = \vartheta_s$$

$$\Rightarrow \vartheta_o = \frac{\vartheta_s}{1 + \frac{1}{G}\left(1 + \frac{R_s}{R_i}\right)}$$

$$= \frac{\vartheta_s}{1 + \frac{1}{2\times10^5}\left(1 + \frac{100}{2\times10^6}\right)}$$

$$\approx \vartheta_s$$