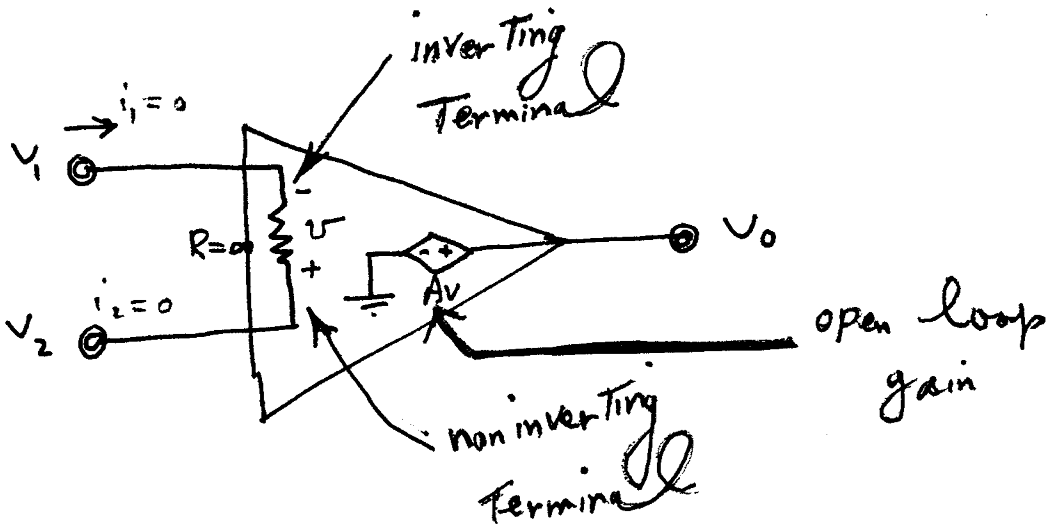
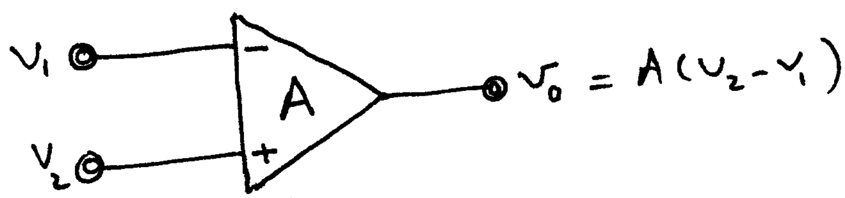
The operational Amplifier – chapter 6

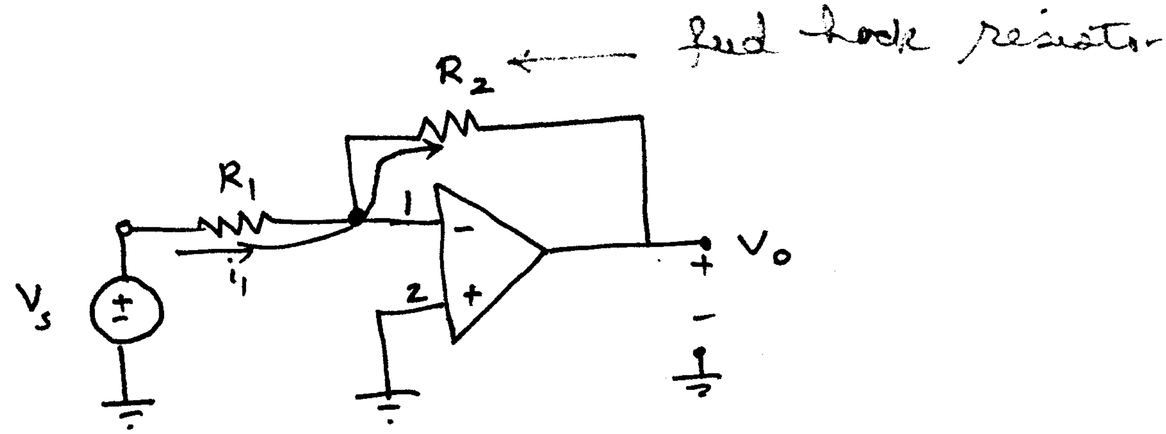


$$v_o = Av = A(v_2 - v_1)$$

The ideal amp is modeled as follows:



The inverting configuration



KCL:

$$\frac{v_s - v_1}{R_1} = \frac{v_1 - v_o}{R_2} \qquad (1)$$

But $\quad v_o = A(v_2 - v_1) \implies v_2 - v_1 = \frac{v_o}{A \to \infty} \to 0. \; (v_2 =$

$$\therefore \quad v_2 = v_1 = 0. \qquad (2)$$

$\therefore$ (2) in (1) $\implies$

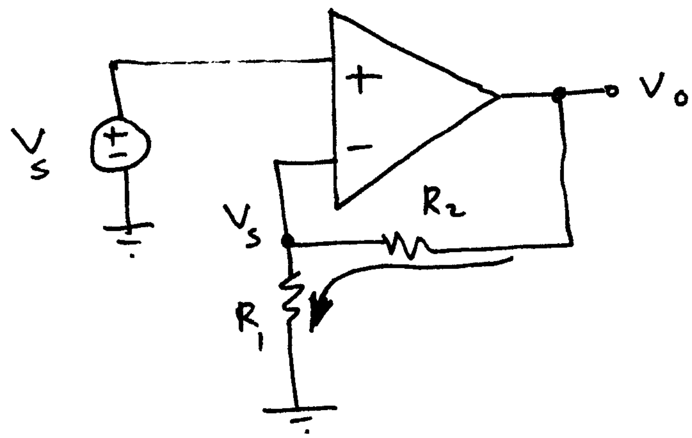
closed loop gain.

$$\frac{v_s}{R_1} = \frac{-v_o}{R_2} \implies v_o = \left(-\frac{R_2}{R_1}\right) v_s .$$

note:

Although $A \to \infty$, for a finite v_s, v_o is finite ($R_1 \neq 0$).

The noninverting configuration



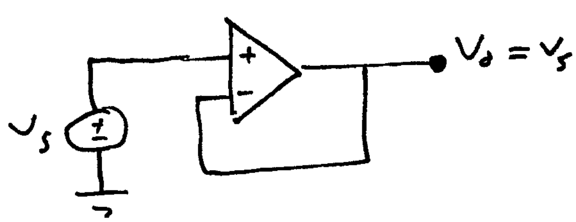
$$\frac{v_o - v_s}{R_2} = \frac{v_s}{R_1} \Rightarrow v_o = \left(\frac{R_2}{R_1} + 1\right) v_s$$

$$\therefore \quad v_o = \left(\frac{R_1 + R_2}{R_1}\right) v_s$$

closed loop gain > 0.

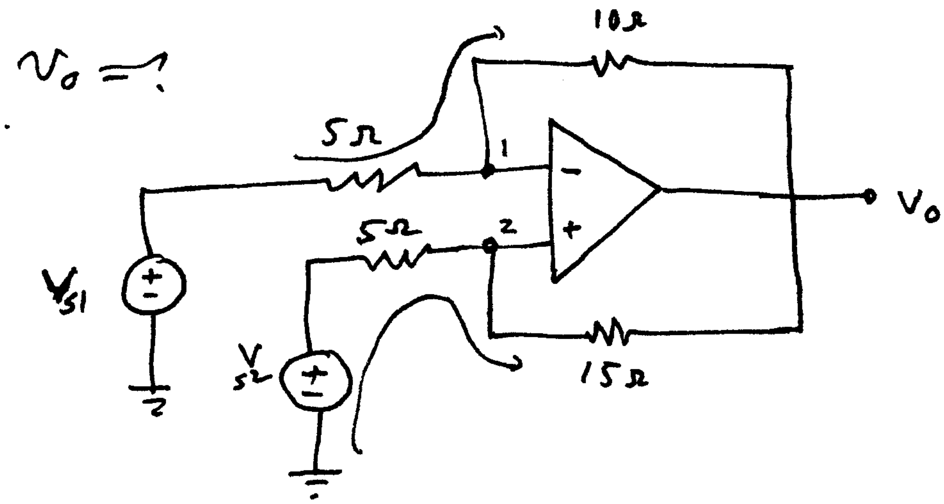
if $R_2 = 0$ and $R_1 \to \infty \Rightarrow v_o = v_s$

and the circuit is called a voltage follower.



#$\frac{2.19}{90}$ (Bobrow):

$V_o = ?$



KCL 1. $\frac{V_{s1} - V_1}{5} = \frac{V_1 - V_o}{10}$ (1)

KCL 2. $\frac{V_{s2} - V_2}{5} = \frac{V_2 - V_o}{15}$ (2)

note that $V_1 \simeq V_2 = V \neq 0$. (3)

(3) in (1) and (2) ⇒

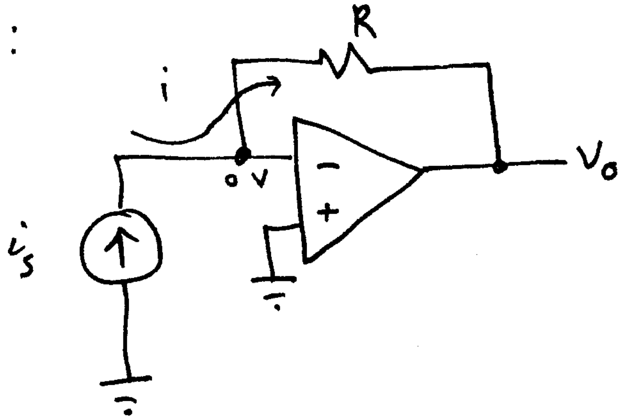
$$V_{s_1} = \frac{1}{2}(V - V_o) + V = \frac{3}{2}V - \frac{1}{2}V_o \quad (4)$$

$$V_{s_2} = \frac{1}{3}(V - V_o) + V = \frac{4}{3}V - \frac{1}{3}V_o \quad (5)$$

eliminate V from (4) and (5) ⇒

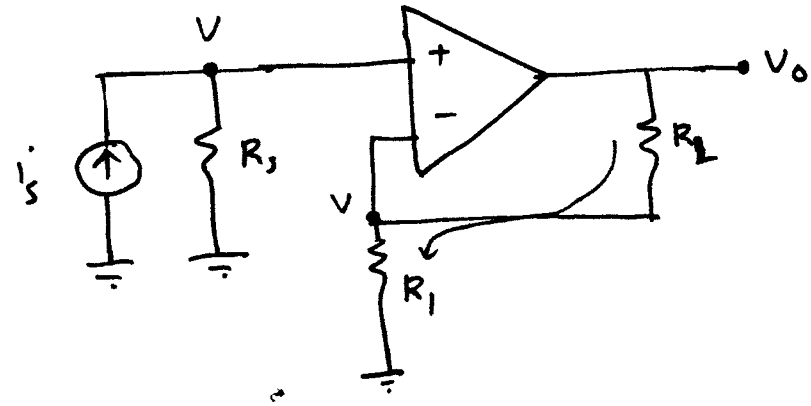
$$\boxed{V_o = -8V_{s_1} + 9V_{s_2}}$$

#$\frac{2.20}{91}$:



$$i_s = \frac{0 - V_o}{R} \Rightarrow \frac{V_o}{i_s} = -R$$

#$\frac{2.22}{91}$:



$$\begin{cases} i_s = \dfrac{V}{R_s} & (1) \\[2ex] \dfrac{V_o - V}{R_L} = \dfrac{V}{R_1} \Rightarrow V_o = \dfrac{R_L}{R_1}V + V & (2) \end{cases}$$

$$\frac{(2)}{(1)} \Rightarrow \frac{V_o}{i_s} = \frac{\left(\frac{R_L}{R_1}+1\right)\cancel{V}}{\frac{1}{R_s}\cancel{V}} = R_s\left(1+\frac{R_L}{R_1}\right).$$