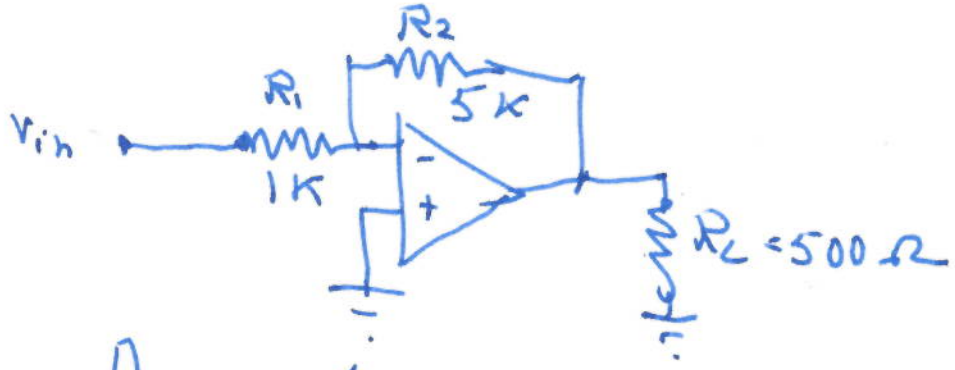
Imperfections

Linear ones: Gain, Bandwidth, Resistance

Non Linear: Saturation.

DC: Bias currents + Voltages.



$A_V = -5$

① $V_{out} = A_V V_{in} = -5 V_{in}$

$V_{out} = V_{supply-} = -12V$

② $V_{out} = V_{supply+} = +12V$

} Piecewise Linear Solution

① $V_{out} = A_V V_{in}$

$-12V < V_{out} < +12V$

$V_- = V_+ = 0$

↑ Real ground

② $V_{out} = 12V$

$V_+ = 0$ ←

$V_- = V_{in} + (V_{out} - V_{in}) \frac{R_1}{R_1 + R_2}$

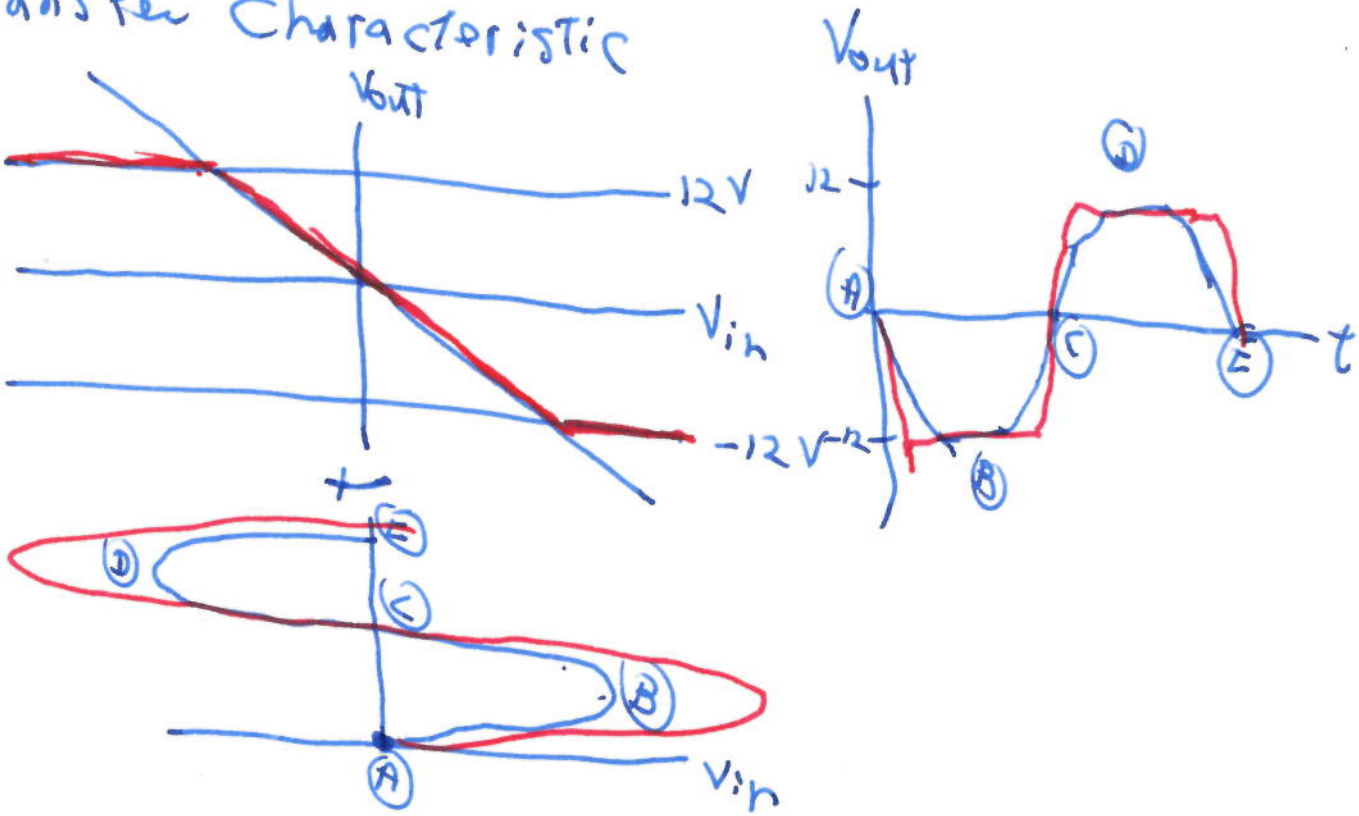
$$V_- = V_{supply+} \frac{R_1}{R_1+R_2} + V_{in} \frac{R_2}{R_1+R_2}$$

$V_- < 0$ test

(3) $$V_- = V_{supply-} \frac{R_1}{R_1+R_2} + V_{in} \frac{R_2}{R_1+R_2}$$

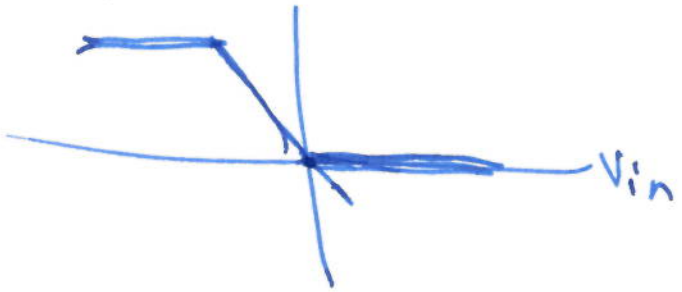
$V_- > 0$ test

Transfer Characteristic



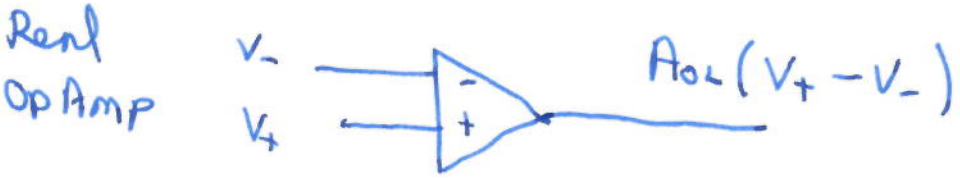
or current limit.

unipolar PS

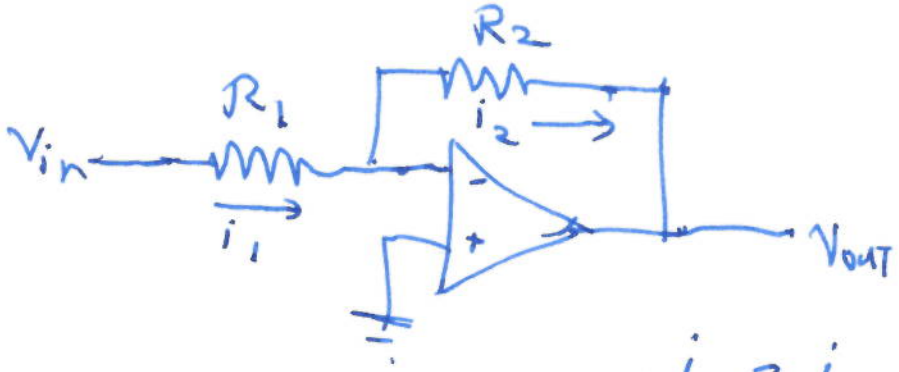


Solution: Capacitive coupling.

Open-loop Gain



A_{OL} large but finite
eg 10^5



$\therefore i_1 = i_2$

(A) $i_1 = (V_{in} - V_-)/R_1$

(B) $i_2 = (V_- - V_{OUT})/R_2$

Not saturated; $V_{OUT} = A_{OL}(V_+ - V_-)$ → 0 Real ground

(A) $\dfrac{V_{in} + \frac{V_{OUT}}{A_{OL}}}{R_1}$ = (B) $-\dfrac{\frac{V_{OUT}}{A_{OL}} - V_{OUT}}{R_2}$

$$\frac{V_{out}}{A_{OL} R_1} + \frac{V_{out}}{A_{OL} R_2} + \frac{V_{out}}{R_2} = - \frac{V_{in}}{R_1}$$

$$A_V = \frac{V_{out}}{V_{in}} = \frac{-1}{R_1\left(\frac{1}{A_{OL} R_1} + \frac{1}{A_{OL} R_2} + \frac{1}{R_2}\right)}$$

$$= - \frac{R_2}{R_1} \; \frac{A_{OL}}{\frac{R_2}{R_1} + 1 + A_{OL}}$$