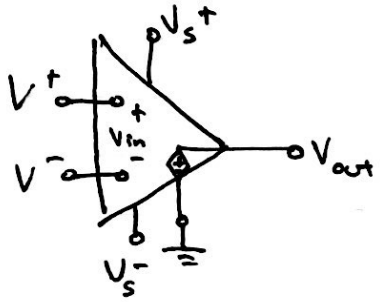
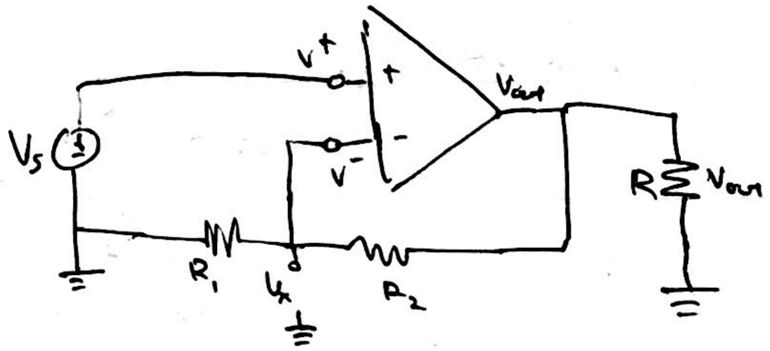
I'M DONE W LATEX

5)



$\Rightarrow$



a) $V_{out} = A(V^+ - V^-)$

$\hookrightarrow V^+ = V_s \qquad V^- = V_x$

$I^+ = I^- = 0$

$\therefore$ R_1, R_2, V_x, V_{out}

$= A(V_s - V_x)$

$V_x = \frac{R_1}{R_1+R_2} V_{out}$

$= A\left(V_s - \frac{R_1}{R_1+R_2} V_{out}\right)$

$= AV_s - A\left(\frac{R_1}{R_1+R_2}\right) V_{out}$

Rearranging,

$V_{out}\left(1 + A\left(\frac{R_1}{R_1+R_2}\right)\right) = A V_s$

$\therefore \boxed{V_{out} = \frac{A}{1 + A\left(\frac{R_1}{R_1+R_2}\right)} V_s} \rightarrow \boxed{V_x = \underbrace{\frac{A\left(\frac{R_1}{R_1+R_2}\right)}{1 + A\left(\frac{R_1}{R_1+R_2}\right)}} V_s}$

★ None of these values depend on R.

★ This implies that the magnitude of V_x is smaller than that of V_s.

b) As $A \to \infty$, the ratios $\to 1$, so

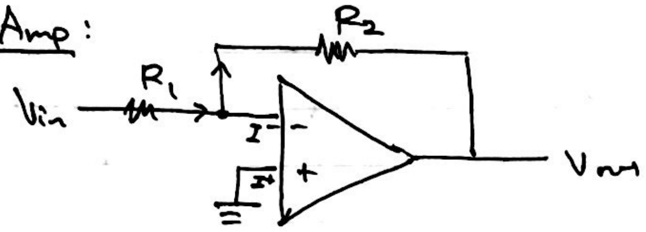
~~both~~ $\boxed{\cancel{V_{out} \text{ and}}}\ \boxed{V_x = V_s}$

Yes, we get the same answers $V_+ = V_- = V_s$ when NFB.

$V_{out} = \left(\frac{R_1+R_2}{R_1}\right) V_x$

$\boxed{V_{out} = \left(\frac{R_1+R_2}{R_1}\right) V_s}$

6) a) Inverting Amp:

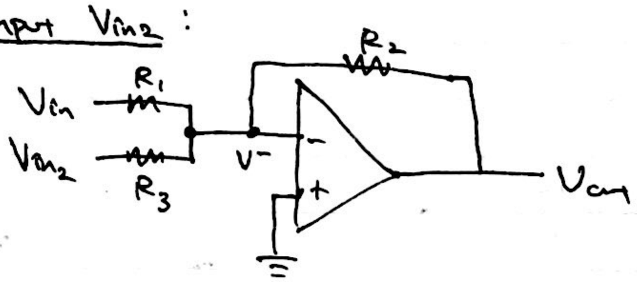


$\left.\begin{array}{l} I^- = I^+ = 0 \\ V^+ = V^- = 0 \end{array}\right\}$, so nodal analysis @ V^- node gives

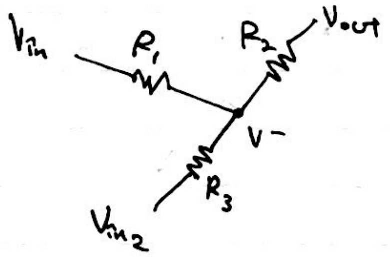
$$\frac{V_{in} - 0}{R_1} = \frac{0 - V_{out}}{R_2}$$

$\therefore$ volt. gain $\boxed{\dfrac{V_{out}}{V_{in}} = -\dfrac{R_2}{R_1}}$

b) Second Input V_{in2}:



Nodal analysis @ V^- node:



$$\frac{V^- - V_{in}}{R_1} + \frac{V^- - V_{in2}}{R_3} + \frac{V^- - V_{out}}{R_2} = 0$$

Since $V^- = V^+ = 0$,

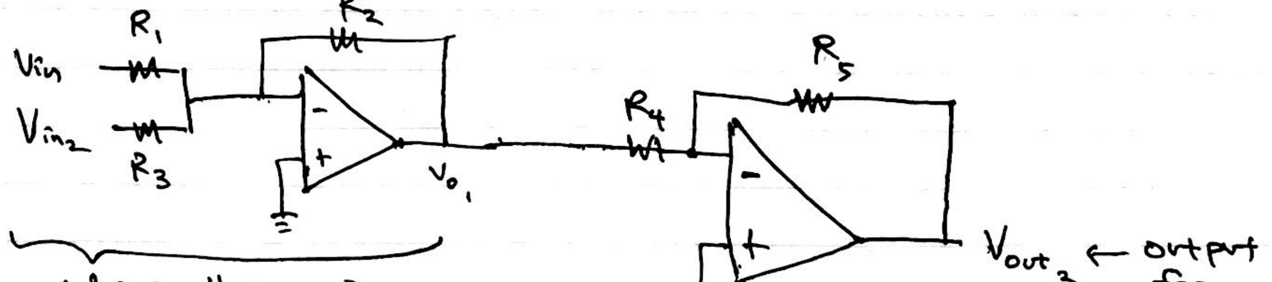
$$\frac{V_{out}}{R_2} = -\frac{V_{in}}{R_1} - \frac{V_{in2}}{R_3}$$

$$\boxed{V_{out} = -\left(\frac{R_2}{R_1} V_{in} + \frac{R_2}{R_3} V_{in2}\right)}$$

c c) To get $V_{out} = -\left(\frac{1}{4} V_{s1} + 2V_{s2}\right)$, we set

$\boxed{\begin{array}{l} R_1 = 8\,k\Omega \\ R_2 = 2\,k\Omega \\ R_3 = 1\,k\Omega \end{array}}$ so that $\frac{R_2}{R_1} = \frac{8}{2} = \frac{1}{4}$, $\frac{R_2}{R_3} = \frac{2}{1} = 2$

d)

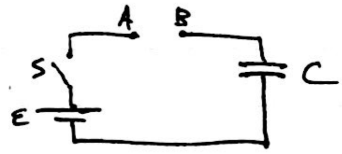


where the resistances can be any that satisfy the ratio $R_1 : R_2 : R_3$
$8 : 2 : 1$

set $R_4 = R_5$ to invert V_{o_1} so that $V_{out_2} = -V_{o_1}$

7) THINK ABOUT I_T!

Question: Consider the following circuit qualitatively:



How will you charge the capacitor?

Answer: <u>Case 1</u>

Attach a wire btwn A & B, then close S. If we assume resistancelessness of the wires, charge flows into the plates super quick that the ~~diff~~ ΔV_c across the capacitor "instantly" becomes equal to ε across the battery.

Thus $Q = C\Delta V_c = \boxed{C\varepsilon}$

<u>Case 2</u>

Insert a resistor btwn A & B, then close S.
We know that at any time, $\varepsilon = \Delta V_R + \Delta V_c$.
@ $t = 0$, $\Delta V_c = 0$, so the current, initially, can just be described as $I_c = \Delta V_R / R = \varepsilon / R$.
As time goes on, ΔV_c increases while ΔV_R decreases, meaning I decreases, and as $I \to 0$, $\Delta V_R \to 0$, $\Delta V_c \to \varepsilon$.
Circuit is now static.