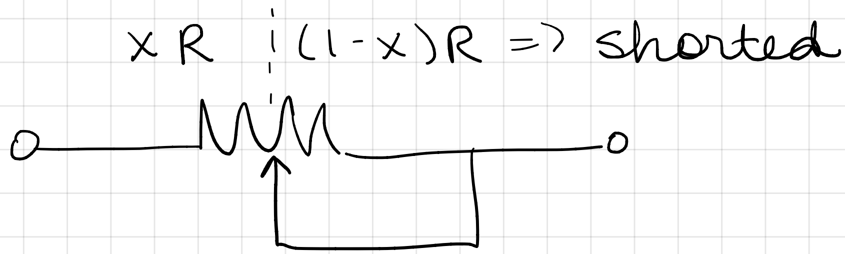
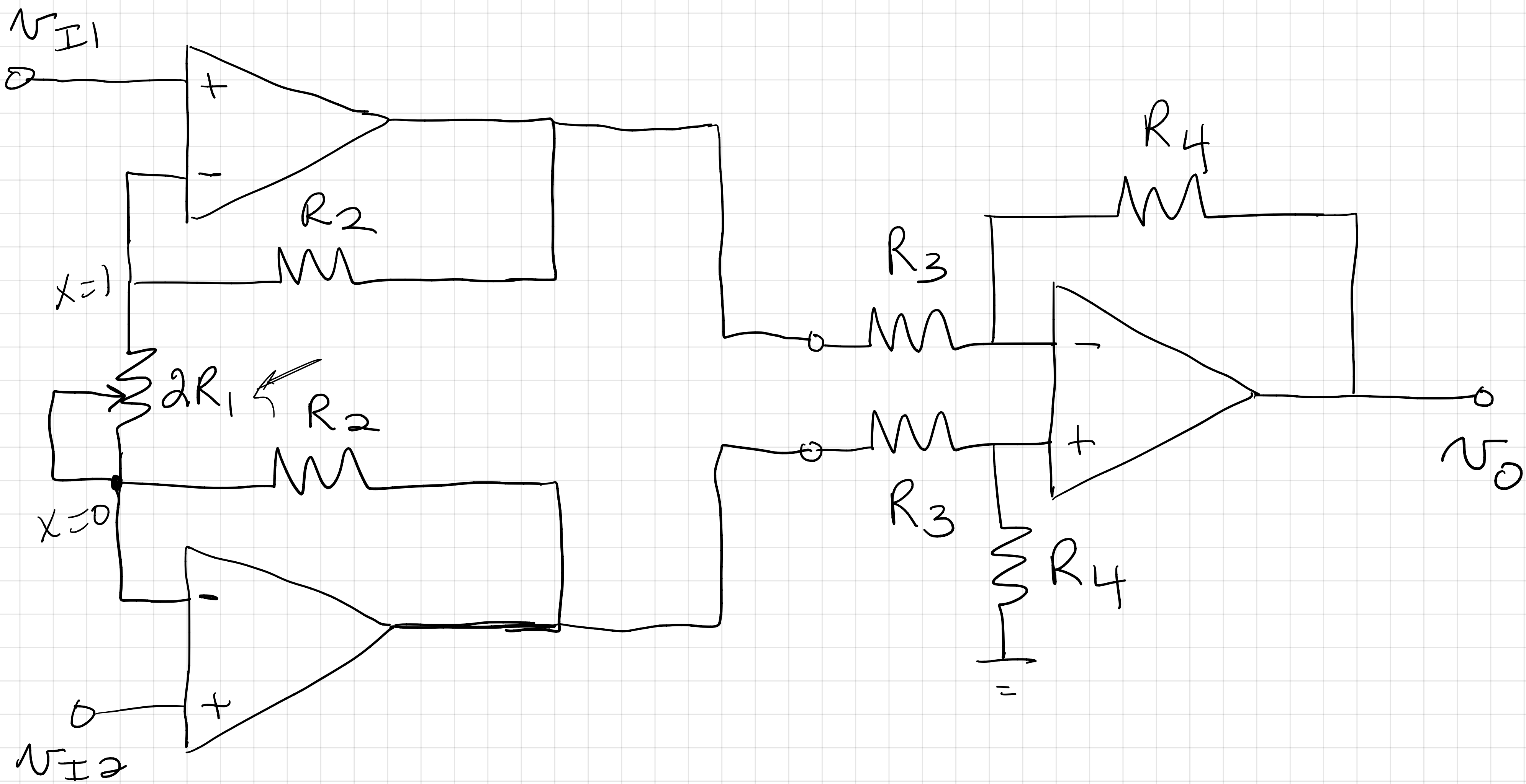
Using a pot to vary gain:





$2R_1 = 100\,k\Omega$ pot.

$$A_d = \left(1 + \frac{2R_2}{2R_1}\right)\left(\frac{R_4}{R_3}\right)$$

$x = 0$ $\quad 2R_1 = 100\,k\Omega$

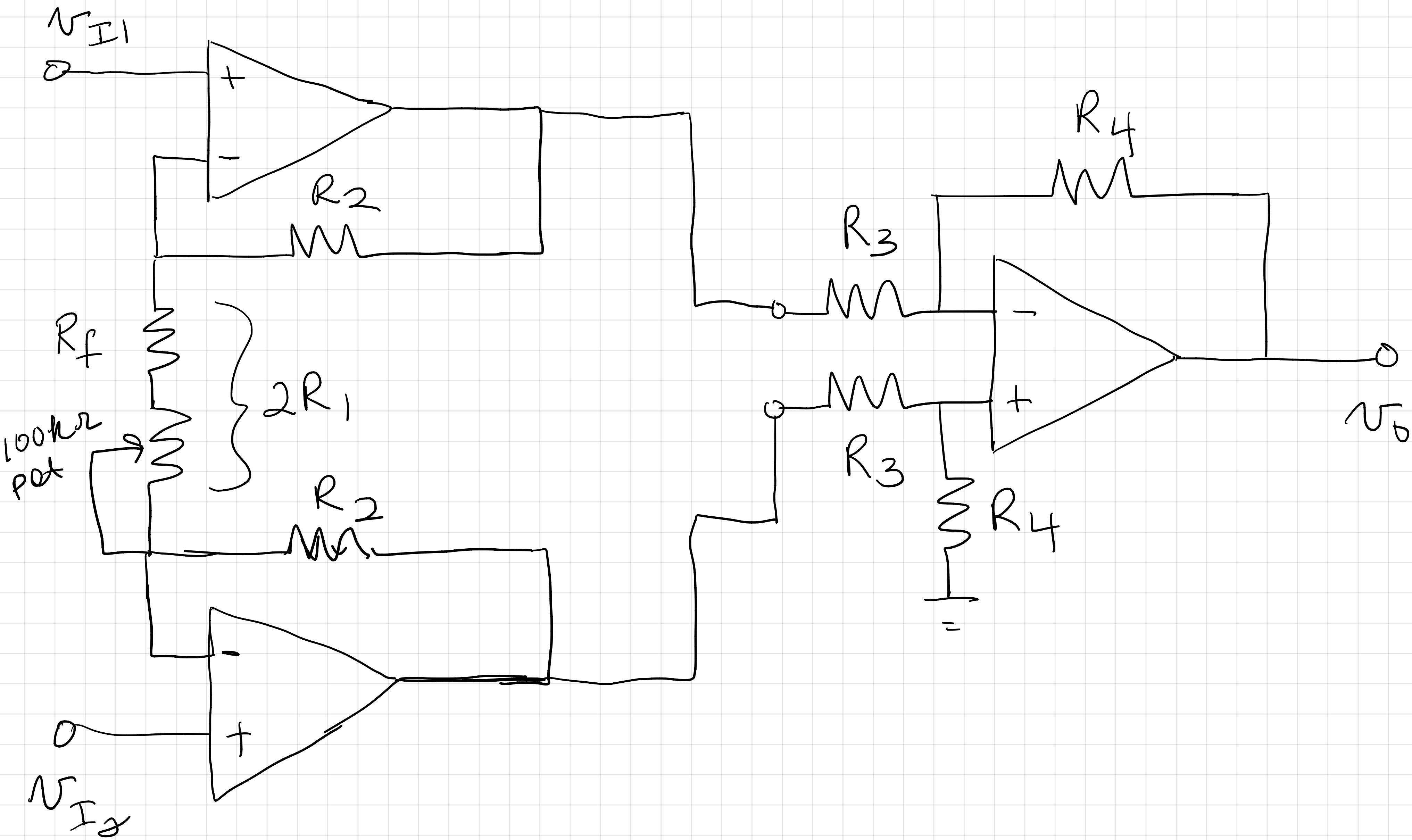
$$A_d = \left(1 + \frac{2R_2}{100k}\right)\left(\frac{R_4}{R_3}\right)$$

$x = 1$ $\quad 2R_1 = 0$

$$A_d = \left(1 + \frac{2R_2}{0}\right)\left(\frac{R_4}{R_3}\right)$$

$x = 0$ $\quad A_d$ = minimum

$x = 1$ $\quad A_d \to \infty$



v_{I1}
R_2
R_4
R_3
R_f
$2R_1$
100kΩ pot
R_2
R_3
R_4
v_o
v_{I2}

Design instrumentation amp

$A_d \rightarrow 2\frac{V}{V}$ to $1000 V/V$

$$A_d = \left(1 + \frac{2R_2}{2R_1}\right)\left(\frac{R_4}{R_3}\right)$$

$$2R_1 = R_f + 100\cancel{k}\Omega$$

$x = 0 \quad 2R_1 = R_f + 100k\Omega$

$$\left(1 + \frac{2R_2}{2R_1}\right)\left(\frac{R_4}{R_3}\right) = 2$$

$$\left(1 + \frac{2R_2}{R_f + 100\times10^3}\right)\left(\frac{R_4}{R_3}\right) = 2$$

let $R_4 = R_3 = 100k\Omega$

$$\boxed{\left(1 + \frac{2R_2}{R_f + 100k}\right) = 2}$$

$x = 1 \qquad 2R_1 = R_f$

$$\left(1 + \frac{2R_2}{2R_1}\right)\left(\cancel{\frac{R_4}{R_3}}^{1}\right) = 1000$$

$$\boxed{\left(1 + \frac{2R_2}{R_f}\right) = 1000}$$

$$\frac{2R_2}{R_f + 100k} = 1 \qquad \frac{2R_2}{R_f} = 999$$

$$\boxed{2R_2 = R_f + 100k} \qquad \boxed{2R_2 = 999R_f}$$

$$R_f + 100k\Omega = 999R_f$$

$$998R_f = 100k\Omega$$

$$R_f = 100.2\Omega$$

$$R_2 = 50.05\ k\Omega$$