

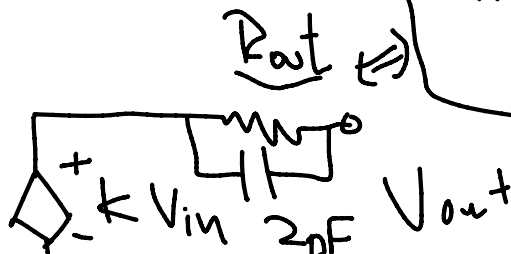
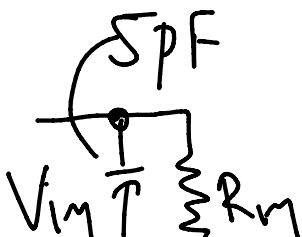
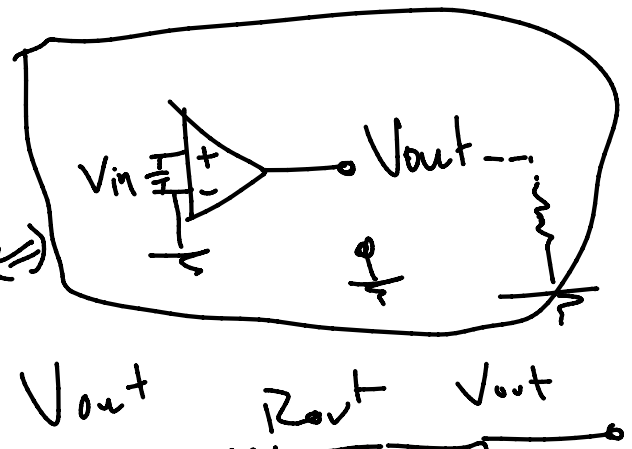
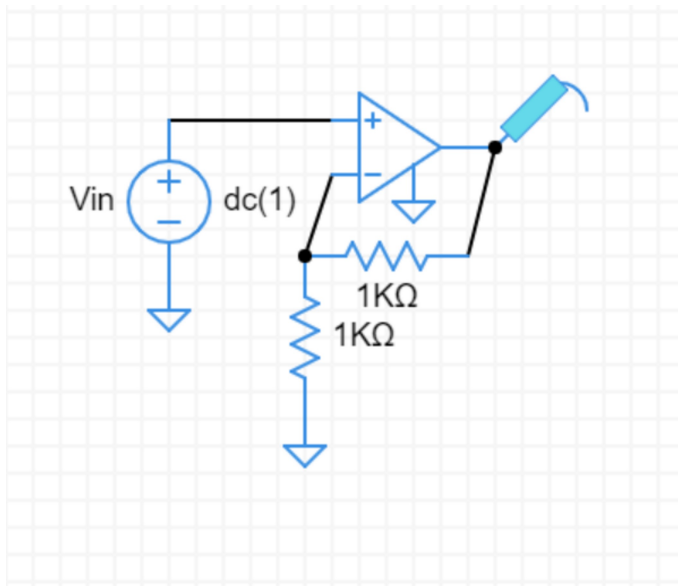
$$10^{-3} \cdot 10^5 = 10^2$$

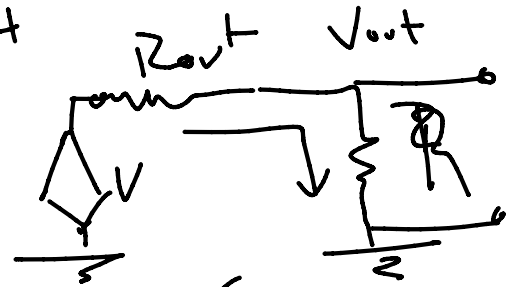
100V

$$\frac{V_{out}}{V} =$$

$$\geq 10.000$$

$$10^5 = 100.000$$

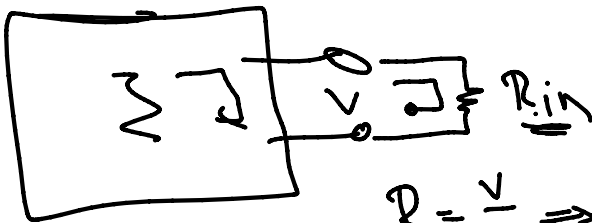




R_{in} 170 nY MEГAΛO $> 2 \text{ nF} = 10^6 \text{ pF}$

$k \rightarrow +\infty$ 90 dB

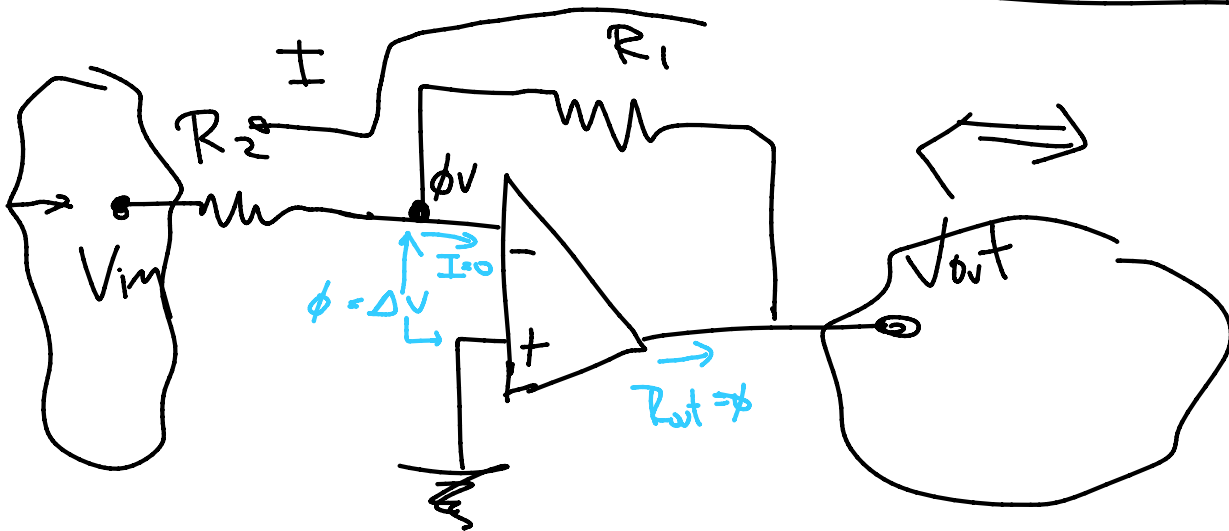
$> 10^{10}$



$$R = \frac{V}{I} \Rightarrow I = \frac{V}{R} \rightarrow \phi$$

$R \gg R_{out}$

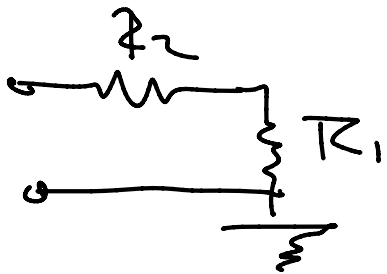
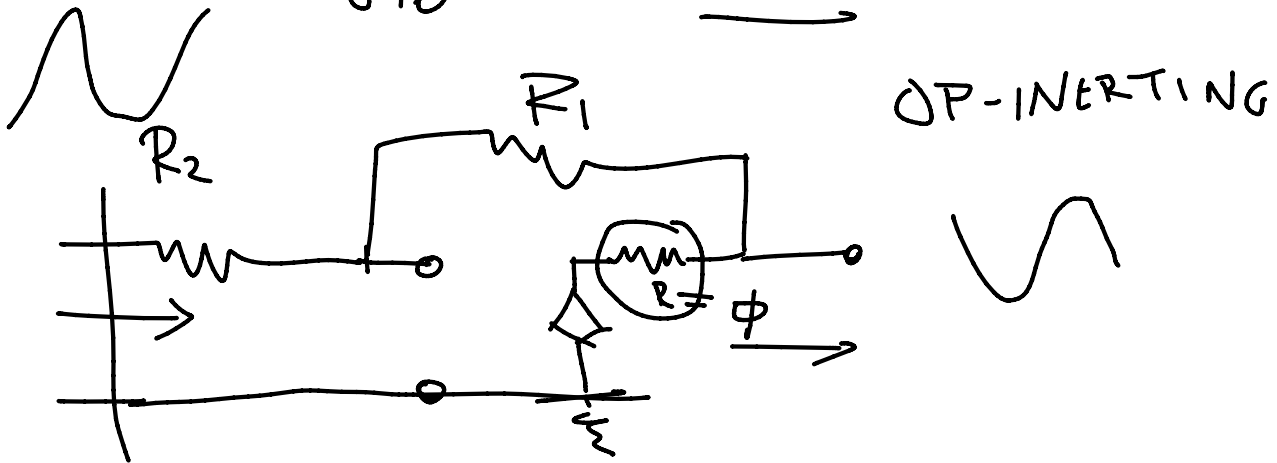
$R_{out} \approx 10 \text{ pF}$



$$\left. \begin{aligned} V_{in} - \phi &= -I \cdot R_2 \\ V_{out} - \phi &= R_1 \cdot I \end{aligned} \right\} \Rightarrow \frac{V_{out}}{V_{in}} = \frac{R_1 \cdot I}{-R_2 \cdot I} \Rightarrow$$

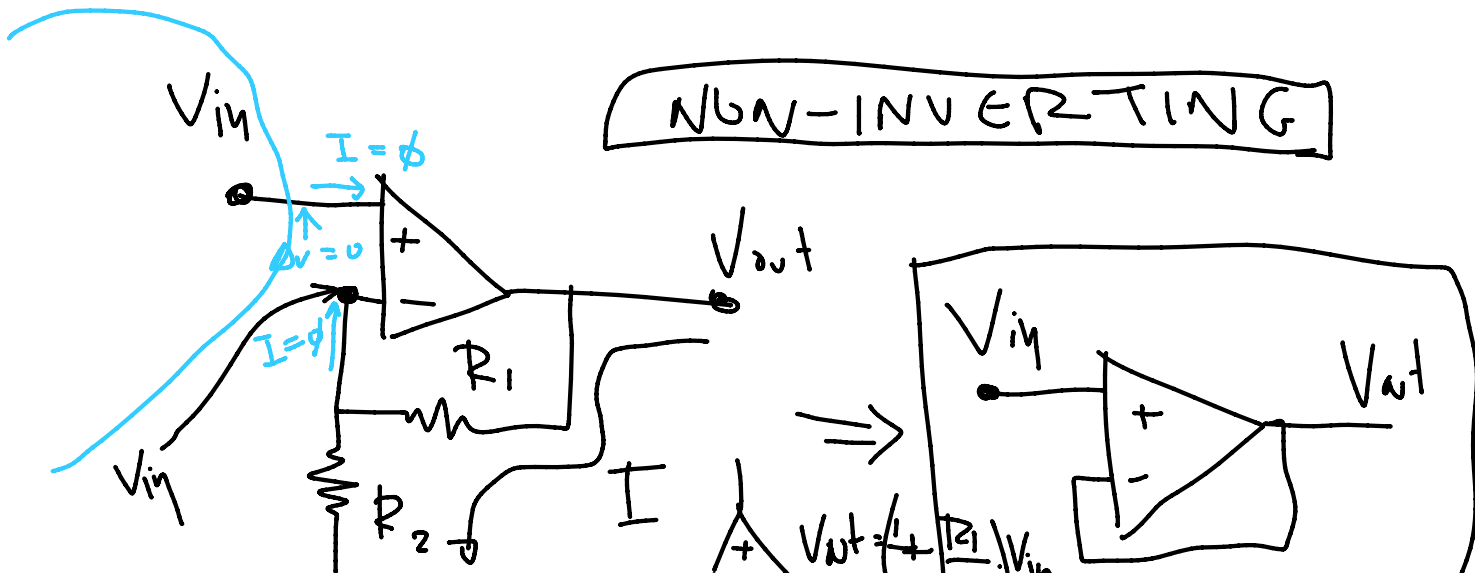
$$\frac{V_{out}}{V_{in}} = \ominus \frac{R_1}{R_2}$$

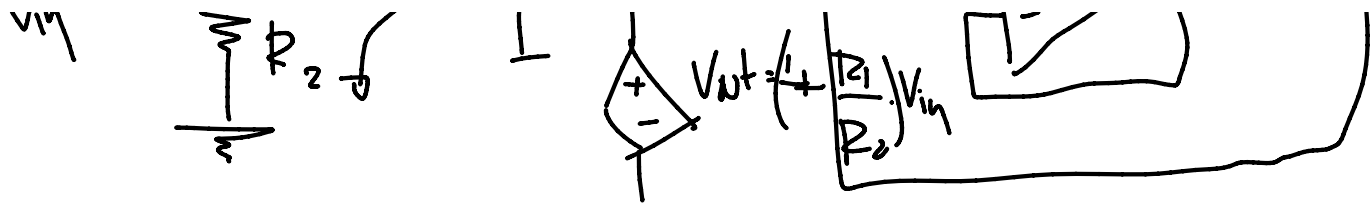
$$20 \log_{10} 2 = 6 \text{ dB}$$



$$R_{IN} = 101 \text{ k}\Omega$$

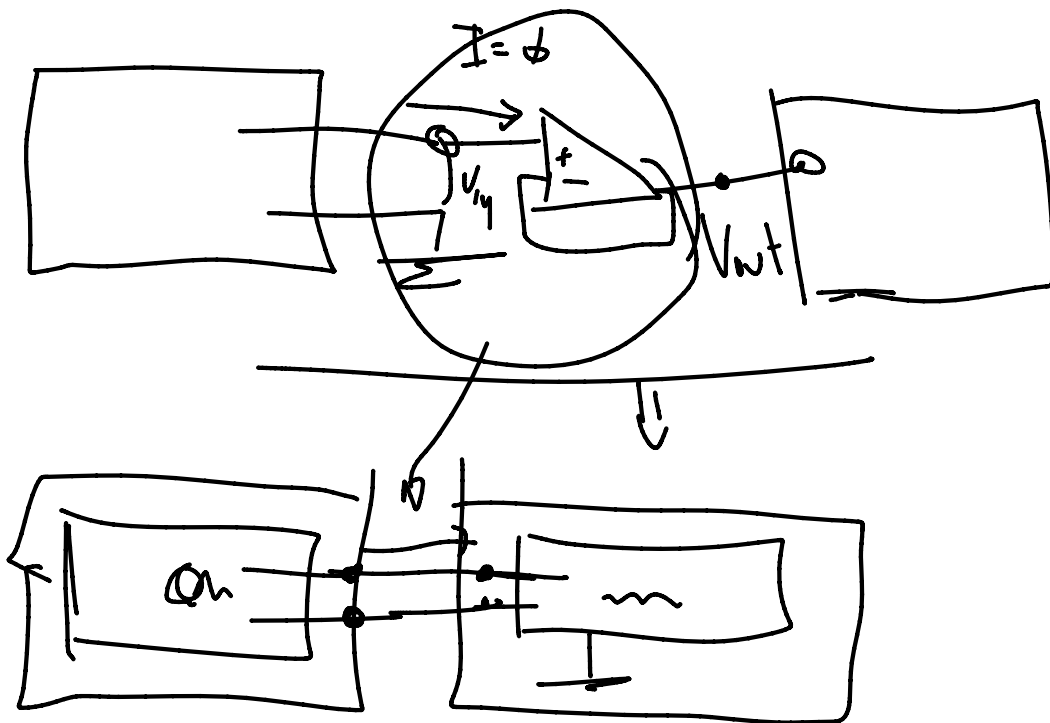
NON-INVERTING

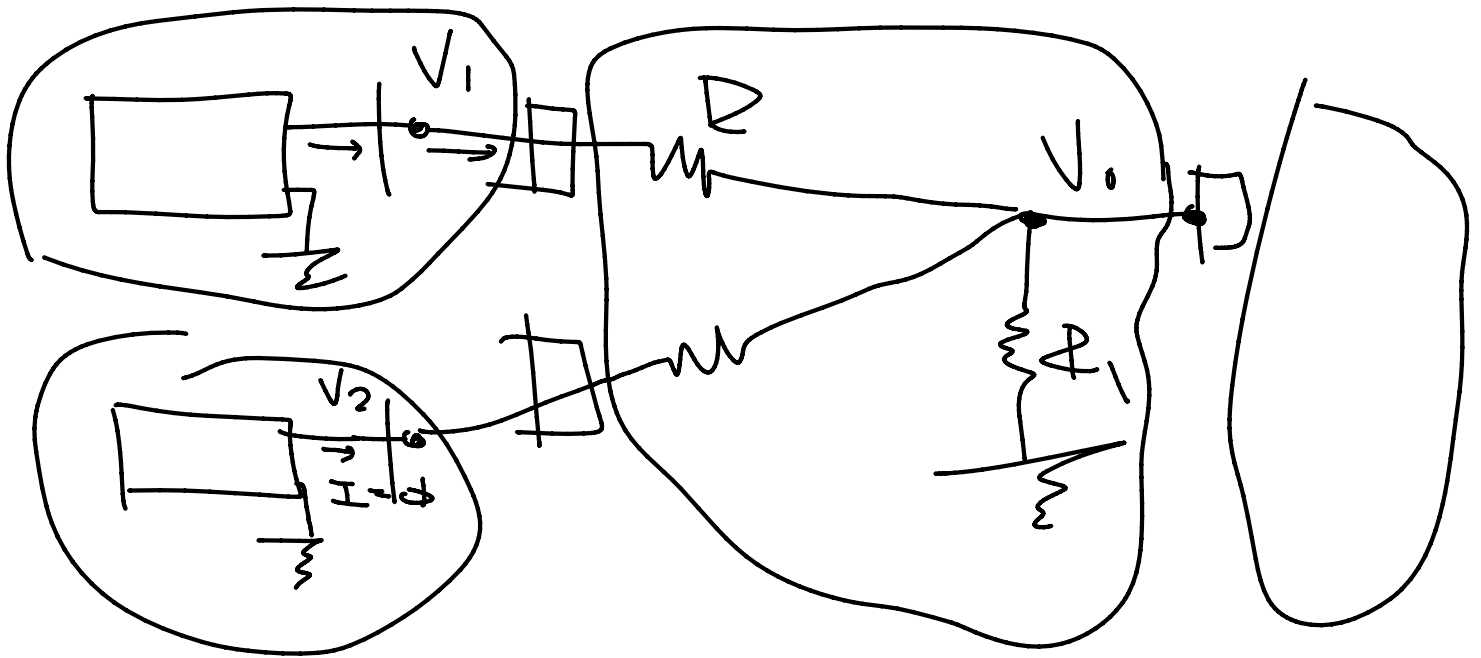




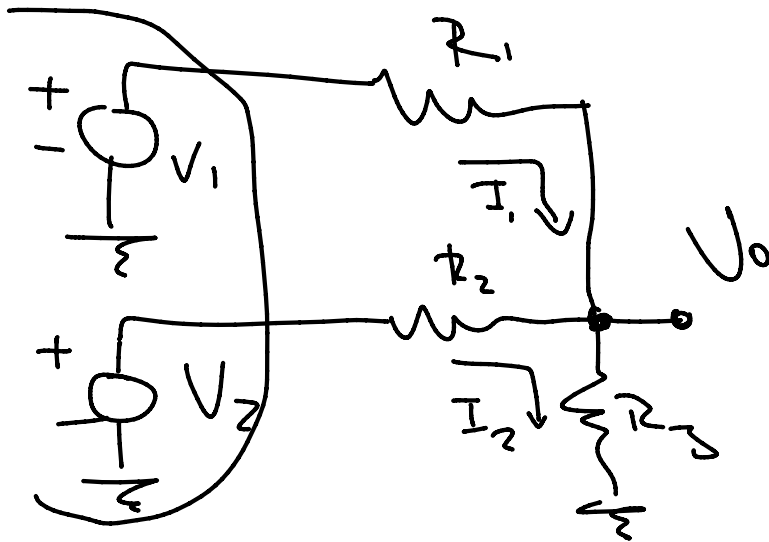
$$\left. \begin{aligned} V_{out} - V_{in} &= R_1 \cdot \underline{I} \\ V_{in} &= R_2 \cdot \underline{I} \end{aligned} \right\} \Rightarrow \frac{V_{out}}{V_{in}} - 1 = \frac{R_1}{R_2} \Rightarrow$$

$$\frac{V_{out}}{V_{in}} = 1 + \frac{R_1}{R_2}$$





$$V_0 = k(V_1 + V_2)$$



$$\left. \begin{aligned} V_0 &= R_3(I_1 + I_2) \\ V_1 &= R_1 I_1 + V_0 \\ V_2 &= R_2 I_2 + V_0 \end{aligned} \right\} \Rightarrow$$

$$V_2 = R_2 I_2 + V_0$$

$$I_1 = \frac{V_1 - V_0}{R_1} \quad I_2 = \frac{V_2 - V_0}{R_2}$$

$$V_0 = R_3 \left(\frac{V_1 - V_0}{R_1} + \frac{V_2 - V_0}{R_2} \right) =$$

$$\Rightarrow V_0 = \frac{R_3}{R_1} V_1 - \frac{R_3}{R_1} V_0 + \frac{R_3}{R_2} V_2 - \frac{R_3}{R_2} V_0$$

$$\Rightarrow \left(\frac{R_3}{R_1} + \frac{R_3}{R_2} + 1 \right) V_0 = \frac{R_3}{R_1} V_1 + \frac{R_3}{R_2} V_2 \Rightarrow$$

$$V_0 = R_1' V_1 + R_2' V_2$$

$$V_0 = k (V_1 + V_2)$$

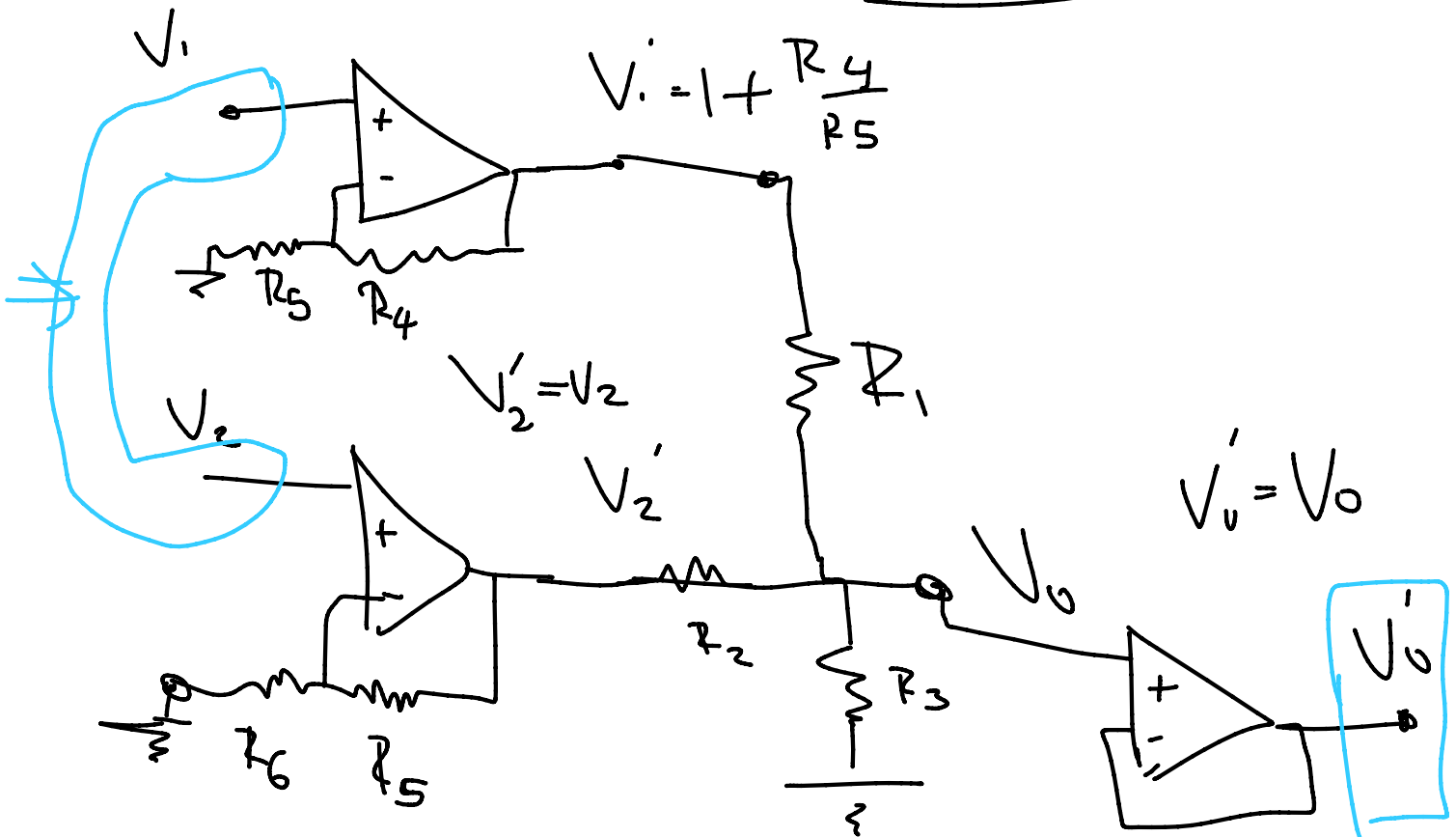
$$k < 1$$

$$\therefore \therefore$$

$$V_0 = k (V_1 + V_2)$$

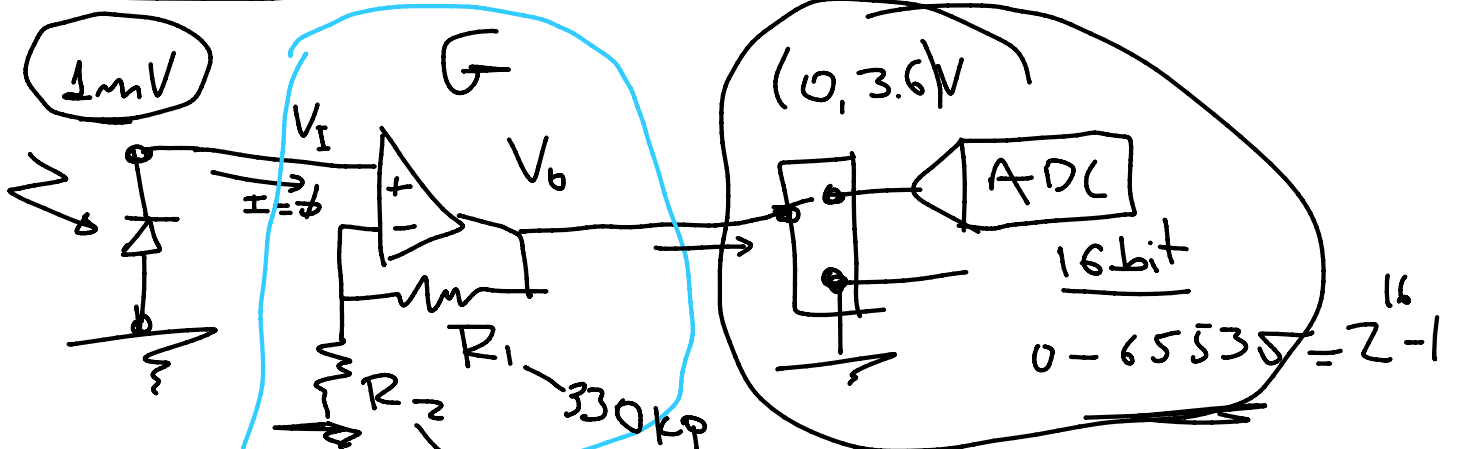
$$V_0 = K(V_1 + V_2)$$

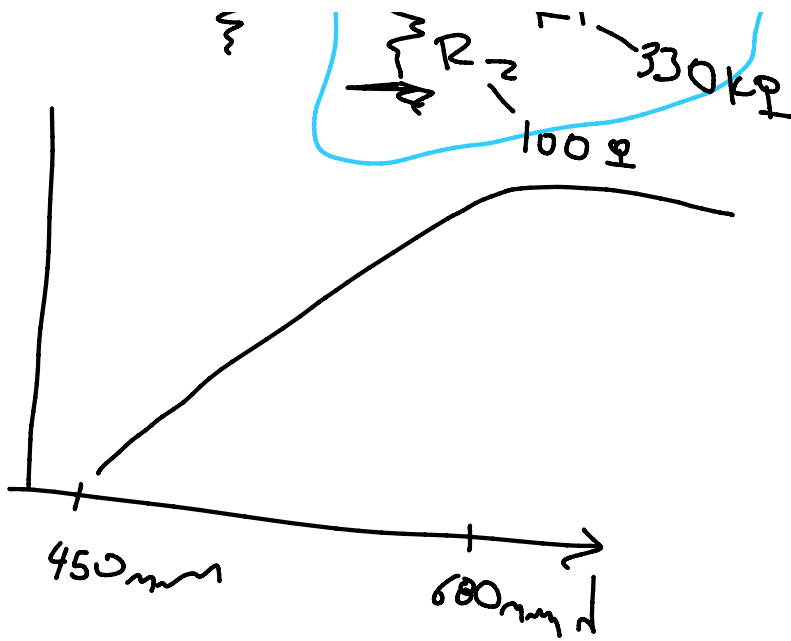
$$V_1' = V_1$$



$$V_2' = 1 + \frac{R_5}{R_6}$$

$$V_0 = k_1 V_1 + k_2 V_2$$



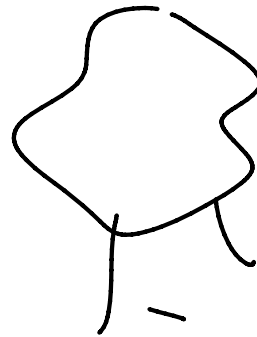
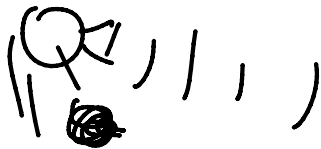


$$G = \frac{3600 \text{ mV}}{1 \text{ mV}} = 3.600$$

$$G = 1 + \frac{R_1}{R_2} \Rightarrow$$

$$\frac{R_1}{R_2} \approx 3600 \quad R_2 = 100 \Omega$$

$$R_1 = 360000 \text{ } 360 \text{ k}\Omega$$



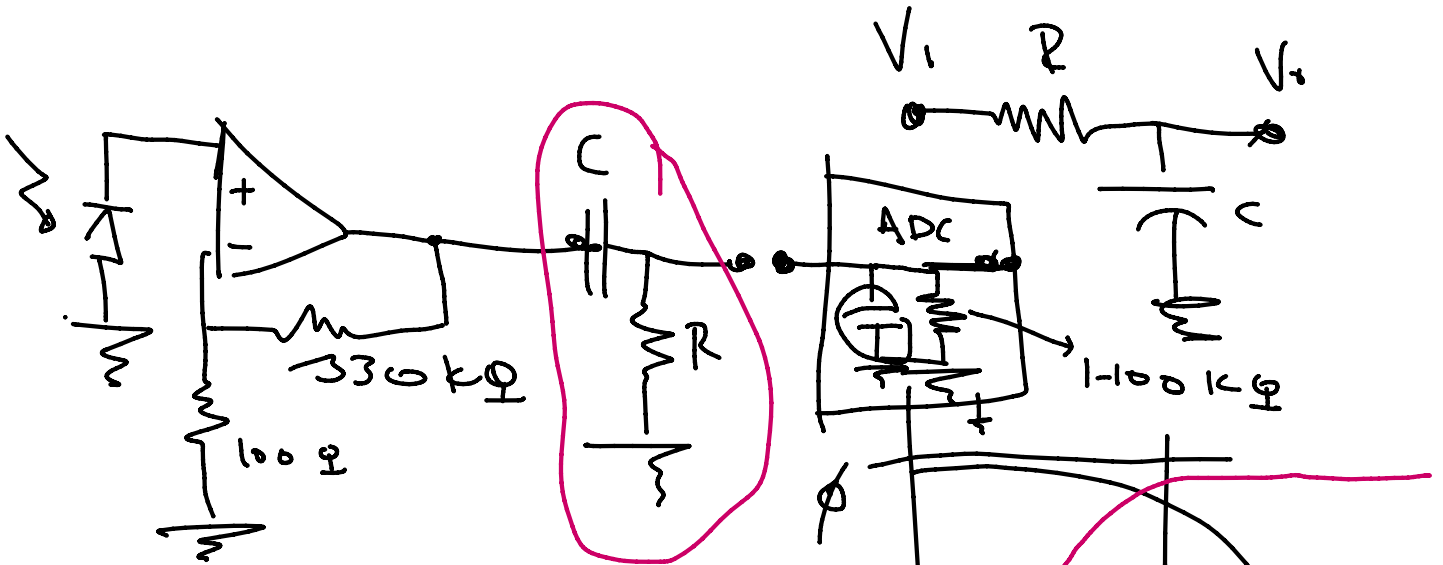
$$G = \frac{330 \text{ k}}{100} + 1 = 3300$$

$$V_{out} = \phi, 33 \text{ V}$$

Resistor Tolerance and E-series Table

E6 Series at $\pm 20\%$ Tolerance - Resistors values in Ω
1.0, 1.5, 2.2, 3.3, 4.7, 6.8
E12 Series at $\pm 10\%$ Tolerance - Resistors values in Ω
1.0, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2
E24 Series at $\pm 5\%$ Tolerance - Resistors values in Ω
1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.2, 8.2, 9.1
E96 Series at $\pm 1\%$ Tolerance - Resistors values in Ω
1.00, 1.02, 1.05, 1.07, 1.10, 1.13, 1.15, 1.18, 1.21, 1.24, 1.27, 1.30, 1.33, 1.37, 1.40, 1.43, 1.47, 1.50, 1.54, 1.58, 1.62, 1.65, 1.69, 1.74, 1.78, 1.82, 1.87, 1.91, 1.96, 2.00, 2.05, 2.10, 2.15, 2.21, 2.26, 2.32, 2.37, 2.43, 2.49, 2.55, 2.61, 2.67, 2.74, 2.80, 2.87, 2.94, 3.01, 3.09,

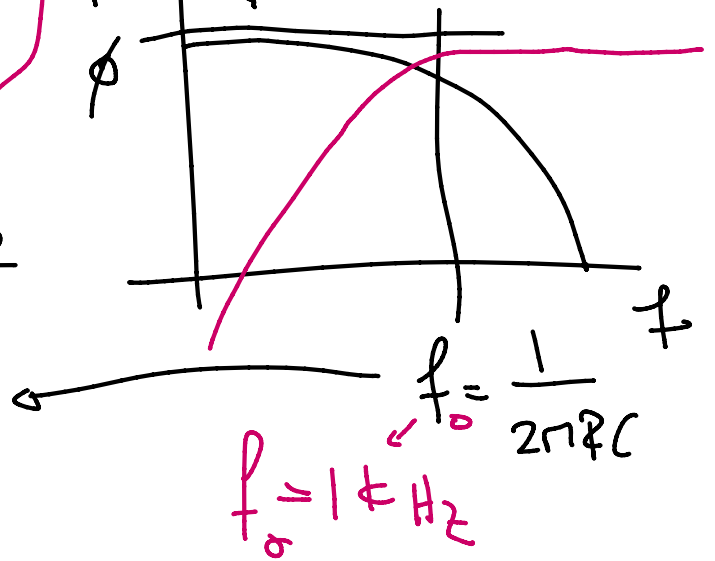
1.00, 1.02, 1.05, 1.07, 1.10, 1.13, 1.15, 1.18, 1.21, 1.24, 1.27, 1.30, 1.33, 1.37, 1.40, 1.43, 1.47, 1.50, 1.54, 1.58, 1.62, 1.65, 1.69, 1.74, 1.78, 1.82, 1.87, 1.91, 1.96, 2.00, 2.05, 2.10, 2.15, 2.21, 2.26, 2.32, 2.37, 2.43, 2.49, 2.55, 2.61, 2.67, 2.74, 2.80, 2.87, 2.94, 3.01, 3.09, 3.16, 3.24, 3.32, 3.40, 3.48, 3.57, 3.65, 3.74, 3.83, 3.92, 4.02, 4.12, 4.22, 4.32, 4.42, 4.53, 4.64, 4.75, 4.87, 4.99, 5.11, 5.23, 5.36, 5.49, 5.62, 5.76, 5.90, 6.04, 6.19, 6.34, 6.49, 6.65, 6.81, 6.98, 7.15, 7.32, 7.50, 7.68, 7.87, 8.06, 8.25, 8.45, 8.66, 8.87, 9.09, 9.31, 9.53, 9.76



$$R = 0.16 \cdot 10^{-3} \cdot 10^9 = 160\text{ k}\Omega$$

$$R = \frac{1}{2\pi C f}$$

$C = 1\text{ mF}$



Tolerances are highly dependent on dielectric and package type.

pF	pF	pF	pF	μF	μF	μF	μF	μF	μF	μF
1.0	10	100	1000	0.01	0.1	1.0	10	100	1000	10,000
1.1	11	110	1100							
1.2	12	120	1200							
1.3	13	130	1300							
1.5	15	150	1500	0.015	0.15	1.5	15	150	1500	
1.6	16	160	1600							
1.8	18	180	1800							
2.0	20	200	2000							
2.2	22	220	2200	0.022	0.22	2.2	22	220	2200	
2.4	24	240	2400							
2.7	27	270	2700							
3.0	30	300	3000							
3.3	33	330	3300	0.033	0.33	3.3	33	330	3300	
3.6	36	360	3600							
3.9	39	390	3900							
4.3	43	430	4300							
4.7	47	470	4700	0.047	0.47	4.7	47	470	4700	
5.1	51	510	5100							
5.6	56	560	5600							
6.2	62	620	6200							
6.8	68	680	6800	0.068	0.68	6.8	68	680	6800	
7.5	75	750	7500							
8.2	82	820	8200							
9.1	91	910	9100							