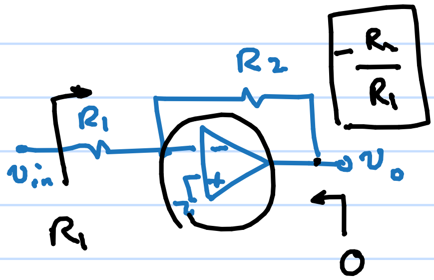
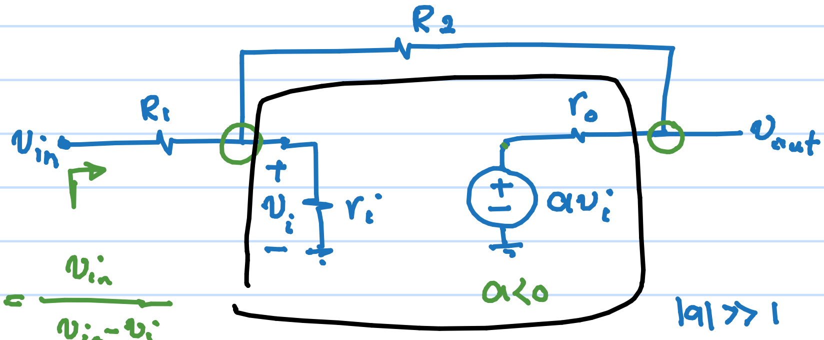




$$R_{in} = \frac{v_{in}}{\frac{v_{in}-v_i}{R_1}}$$

$|a| \gg 1$

$r_i \gg R_1, R_2 \gg r_o$

(*)
$$\frac{v_i}{r_i} + \frac{v_i - v_{out}}{R_2} + \frac{v_i - v_{in}}{R_1} = 0$$

$$\frac{v_{out} - a v_i}{r_o} + \frac{v_{out} - v_i}{R_2} = 0 \rightarrow v_{out}\left(\frac{1}{r_o} + \frac{1}{R_2}\right) = v_i\left(\frac{1}{R_2} + \frac{a}{r_o}\right)$$

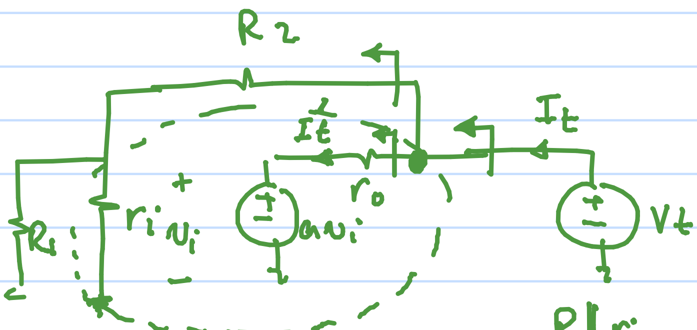
$$v_{out} = v_i \frac{r_o \| R_2}{\frac{r_o}{a} \| R_2} \approx a v_i$$

$$v_i = \frac{1}{a} v_{out}$$

$$\frac{v_{in}}{R_1} + v_{out}\left(\frac{\frac{r_o}{a} \| R_2}{r_o \| R_2} \cdot \frac{\frac{r_o}{a R_2} + \frac{1}{a}}{R_1 \| r_i \| R_2} - \frac{1}{R_2}\right) = 0 \approx \boxed{\frac{v_{out}}{v_{in}} = -\frac{R_2}{R_1}}$$

$= \frac{1}{a}$ $\qquad$ $\frac{1}{a(R_1 \| R_2 \| r_i)}$ $\qquad$ $r_o \ll R_2$

$$R_{in} = R_1 \frac{v_{in}}{v_{in} - v_i} = \frac{R_1}{1 + \frac{R_2}{a R_1}} \approx \boxed{R_1}$$



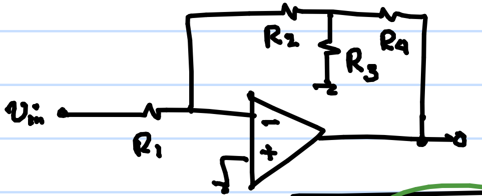
$$R_{out} = (R_2 + r_i \| R_1) \,\Big\|\, \frac{V_t}{I_t'}$$

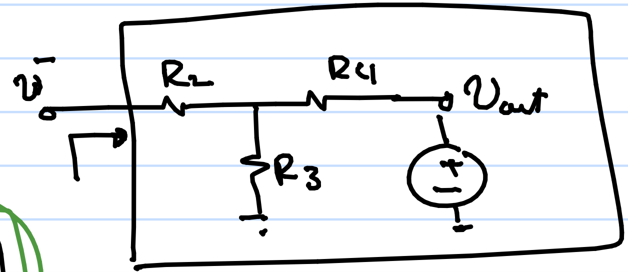
$$I_t' = \frac{V_t - a v_i}{r_o}$$

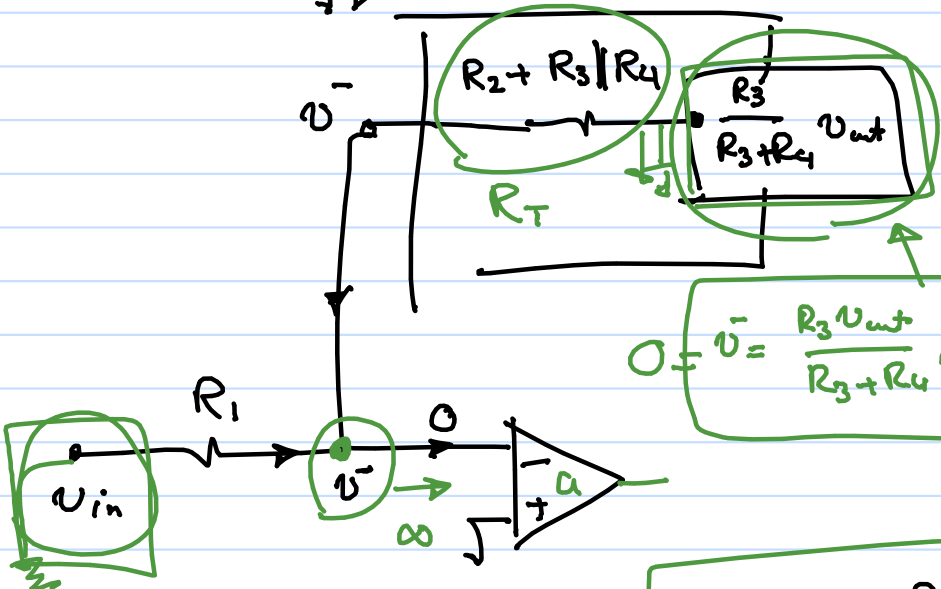
$$= V_t \left(\frac{1 - a \frac{R_1 \| r_i}{R_1 \| r_i + R_2}}{r_o}\right) \qquad R_1$$

$$v_i = \frac{R_1 \| r_i}{R_1 \| r_i + R_2} V_t$$

$$R_{out} = (\overbrace{R_2 + R_1 \| r_i}^{R_1 + R_2}) \,\Big\|\, \frac{r_o}{-a\left(1 + \frac{R_2}{R_1}\right)} \approx \boxed{\frac{r_o}{|a|\left(1 + \frac{R_2}{R_1}\right)}} \approx 0$$







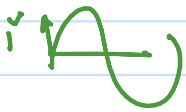
$$0 = v^- = \frac{R_3 v_{out}}{R_3+R_4} \times \frac{R_1}{R_1 + R_2 + R_3 \| R_4} + v_{in} \frac{R_2 + R_3 \| R_4}{R_2 + R_3 \| R_4 + R_1}$$

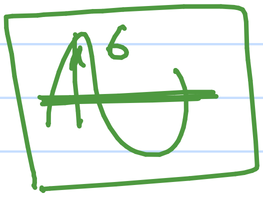
(R_T, R_T)

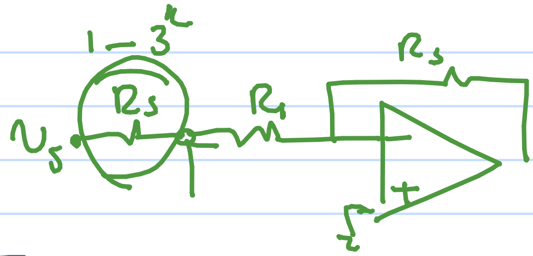
$$\frac{v_{out}}{v_{in}} = -\frac{R_2 + R_3 \| R_4}{R_1} \times \frac{R_3+R_4}{R_3}$$

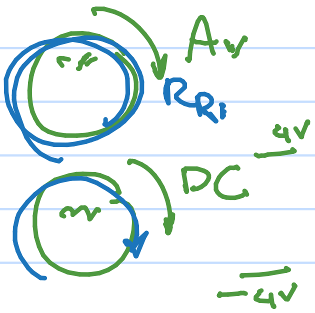
If $R_3 = \infty$ $\quad A_v = -\frac{R_2 + R_4}{R_1}$

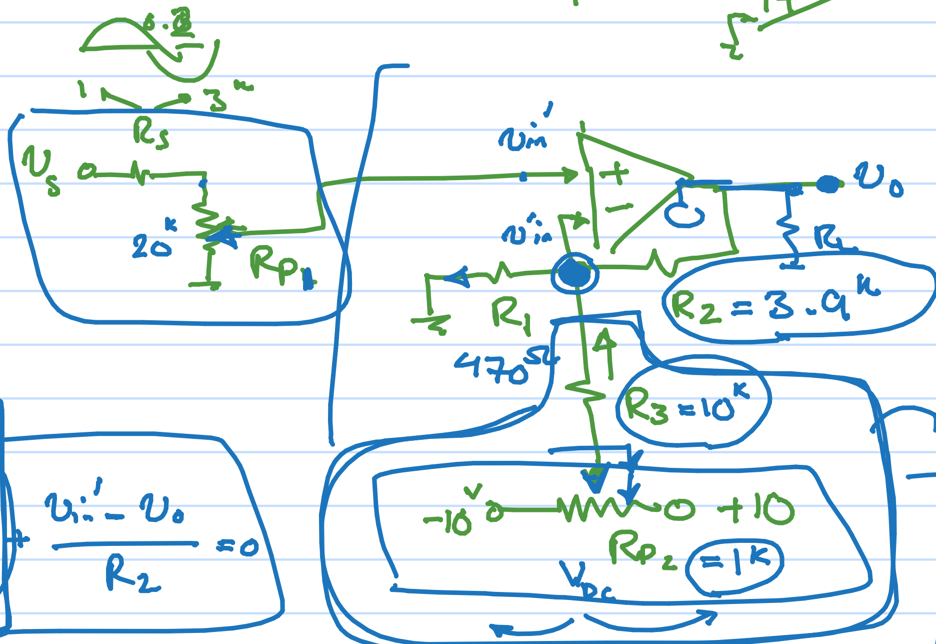
[4]

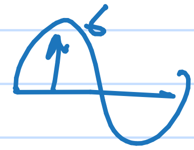


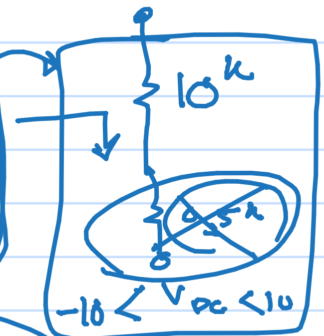












$$\frac{v_{in}'}{R_1} + \frac{v_{in}' - V_{DC}}{R_3} + \frac{v_{in}' - v_o}{R_2} = 0$$

$$v_o = v_{in}'\left(1 + \frac{R_2}{R_1} + \frac{R_2}{R_3}\right) - V_{DC}\frac{R_2}{R_3}$$

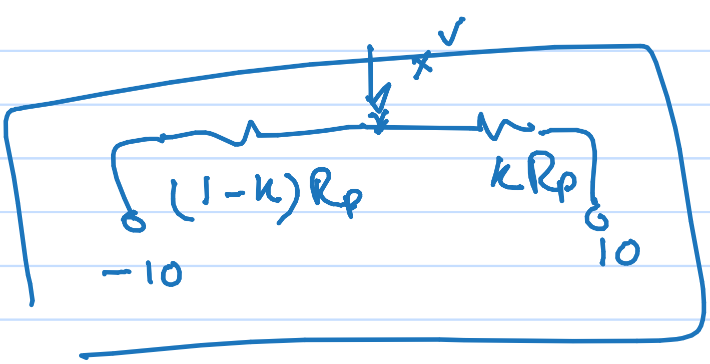
$10 \rightarrow R_1 = 465\Omega \rightarrow 470\Omega$

$$\frac{R_2}{R_3} = \frac{4}{10}$$

$$0.2 < \frac{R_{R_1}}{R_{R_1} + R_s} \times 10 < 6 \rightarrow 0.02 < \frac{R_s}{R_p} < 1.5$$

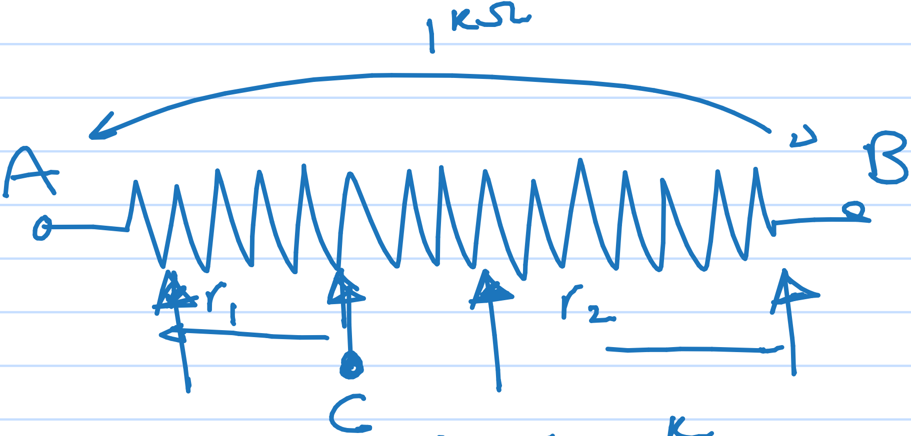
تضعيف

$$0.2^k < R_p < 15^k$$



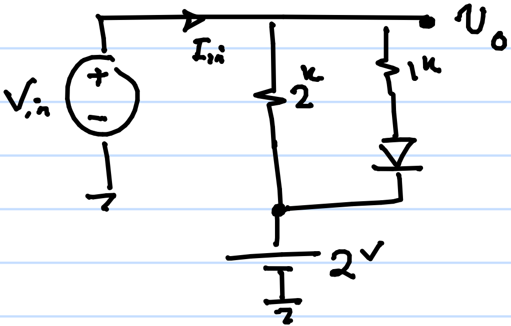
$$x = 10\frac{k}{R_p} + \frac{-10(1-k)}{R_p}$$

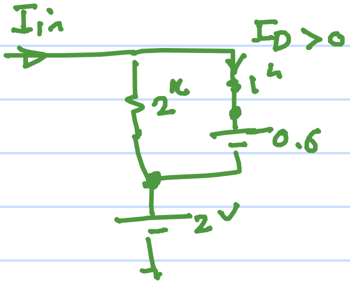
$R_L \gg R_T$

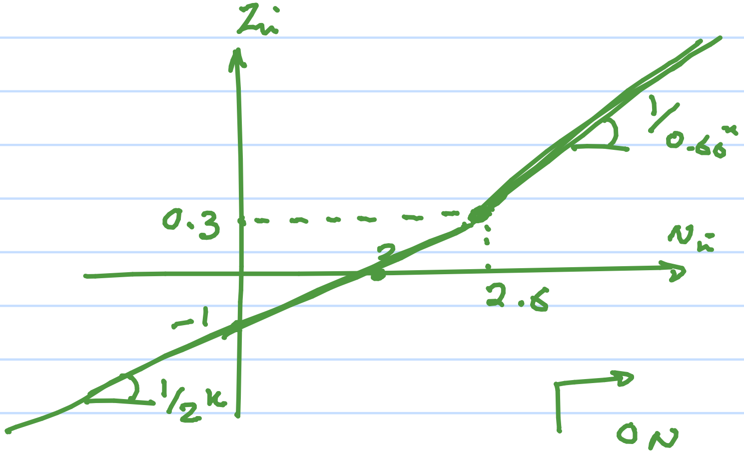


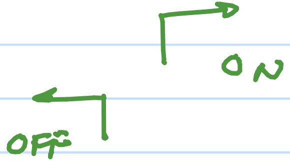
$r_1 + r_2 = 1K$

5



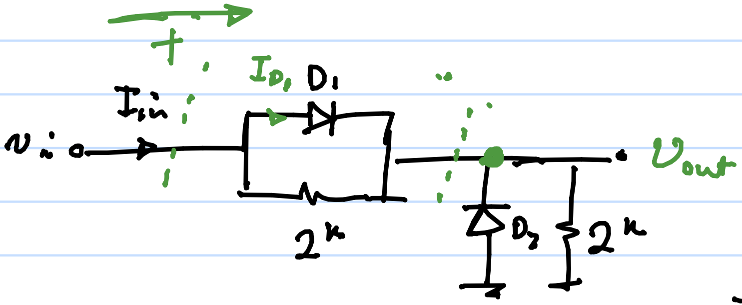


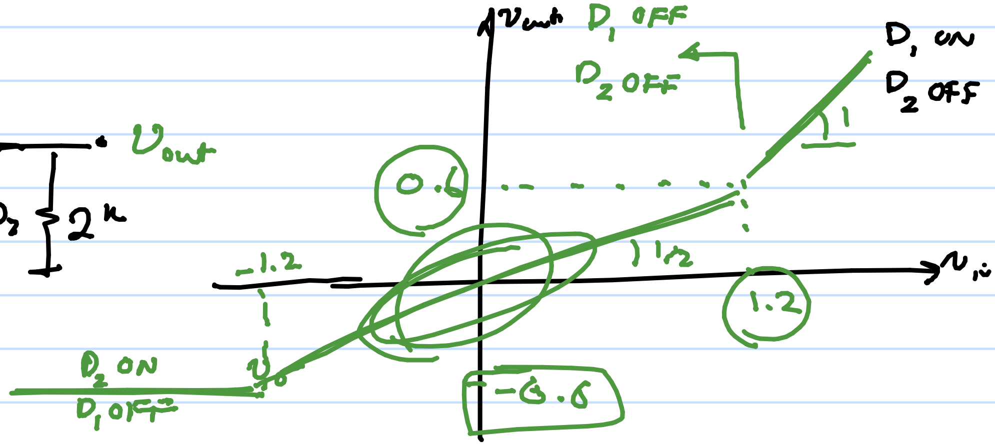




$$I_{in} = \frac{v_i - 2}{2^k} + \frac{v_i - 2.6}{1^k}$$

$$= \frac{v_i}{2^k \| 1^k} - 3.6$$

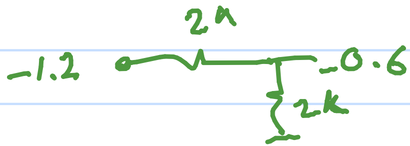


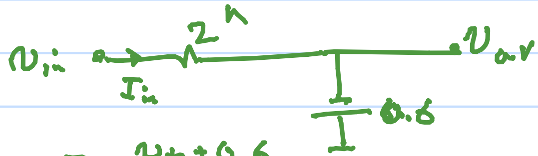


$$I_{in} = I_{2k} = \frac{v_o}{2k} = \frac{v_{in} - 0.6}{2k}$$

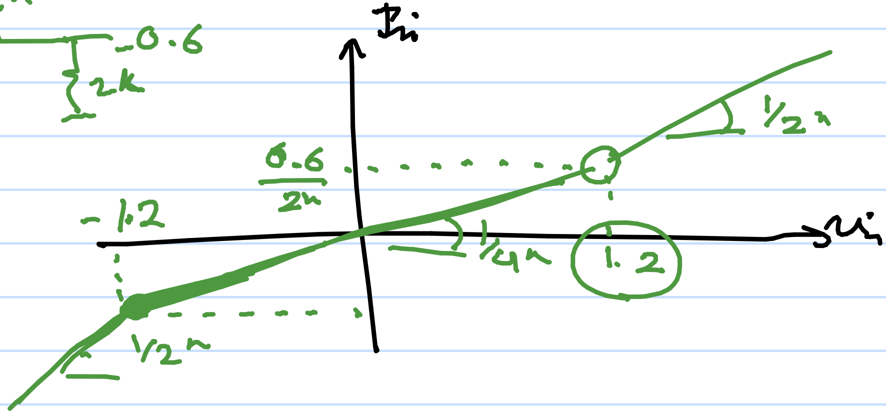
$$I_{D_1} = I_{in} - \frac{0.6}{2k} > 0$$

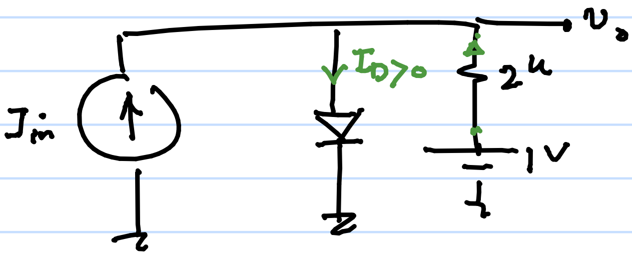
$$I_{in} > \frac{0.6}{2k}$$

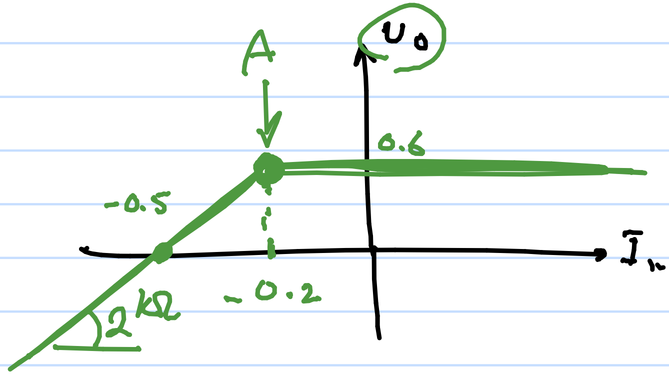




$$I_{in} = \frac{v_{in} + 0.6}{2k}$$

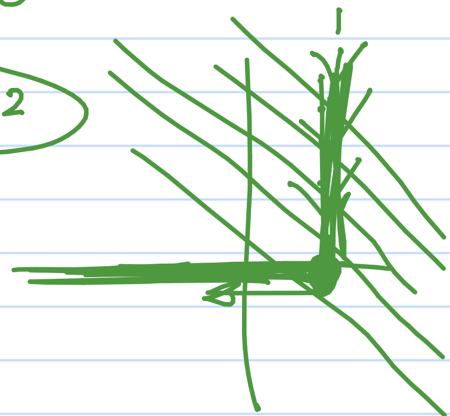






D : ON $\quad v_o = 0.6 \quad I_D = I_{in} + \dfrac{0.4}{2k} > 0$

$I_{in} > -0.2$



D : OFF $\quad v_D < 0$

$v_o = 1^V + 2^k \times I_{in}$