a) $t_{REF}\left(\frac{FI_2}{OD_1} + \frac{FI_3}{OD_2} + \frac{FI_4}{OD_3}\right)$ NOR: $\frac{3k+1}{4}$

$FI_2 = 8(7/4) + 2 + 1$ $\quad OD_1 = 3$

$FI_3 = 6\left(\frac{10}{4}\right) + 2\left(\frac{13}{4}\right)$ $\quad OD_2 = 1$

$FI_4 = \frac{C_L}{C_{REF}} = \frac{160\,fF}{2\,fF}$ $\quad OD_3 = 2$

1.34 nsec $\quad (t_{REF} = 67.1)$

b) $\frac{t_{REF}}{2}\left[FI_2\left(\frac{1}{OD_{1HL}} + \frac{1}{OD_{1LH}}\right) + FI_3\left(\frac{1}{OD_{2HL}} + \frac{1}{OD_{2LH}}\right) + FI_4\left(\frac{1}{OD_{3HL}} + \frac{1}{OD_{3}}\right)\right.$

$FI_1 = 3/2$ $\quad OD_{1HL} = 1$ $\quad OD_{2HL} = 1$ $\quad OD_{3HL} = 1$

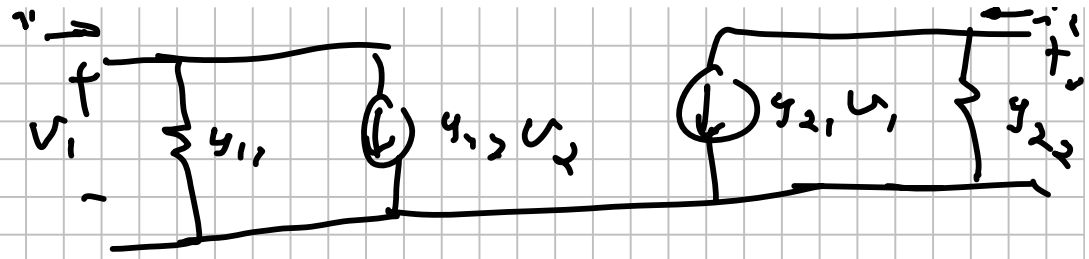
$FI_3 = 1$ $\quad OD_{1LH} = 1/12$ $\quad OD_{2LH} = 1/3$ $\quad OD_{3LH} = 1/12$

$FI_4 = \frac{160}{2}$

532 t_{REF} = 10.6 nsec

a) $I_1 = 2V_1 + 4V_2^2$

$I_2 = 8V_1^3 + .25V_2$



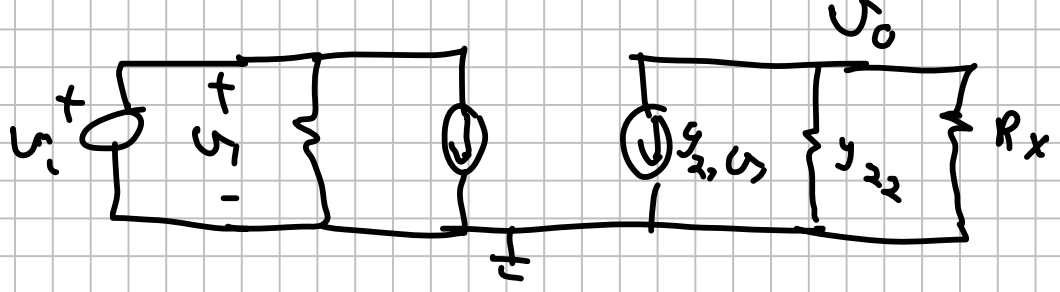
$$y_{11} = \frac{\partial I_1}{\partial V_1}\Big|_Q = 2$$

$$y_{12} = \frac{\partial I_1}{\partial V_2}\Big|_Q = 8V_2\Big|_Q = 16$$

$$y_{21} = \frac{\partial I_2}{\partial V_1}\Big|_Q = 24V_1^2\Big|_Q = 24$$

$$y_{22} = \frac{\partial I_2}{\partial V_2}\Big|_Q = 1/4$$

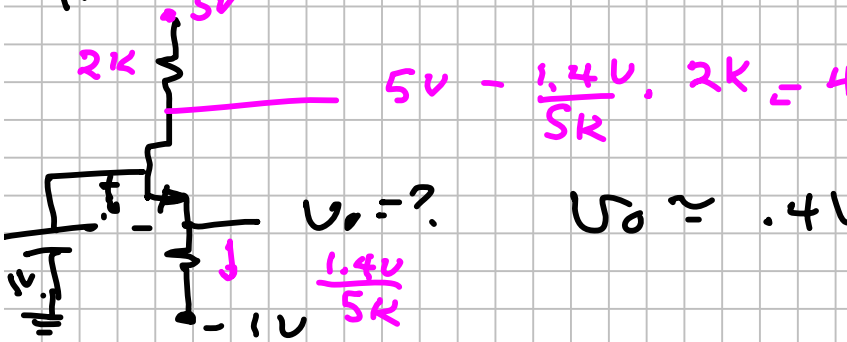
b)



$$A_i = \frac{-y_{21}}{y_{22} + 1/R_x} = -12$$

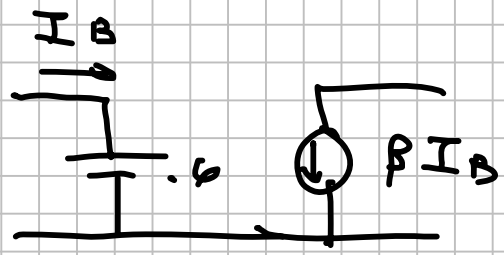
$V_{oQ} = 3V$

Problem 3

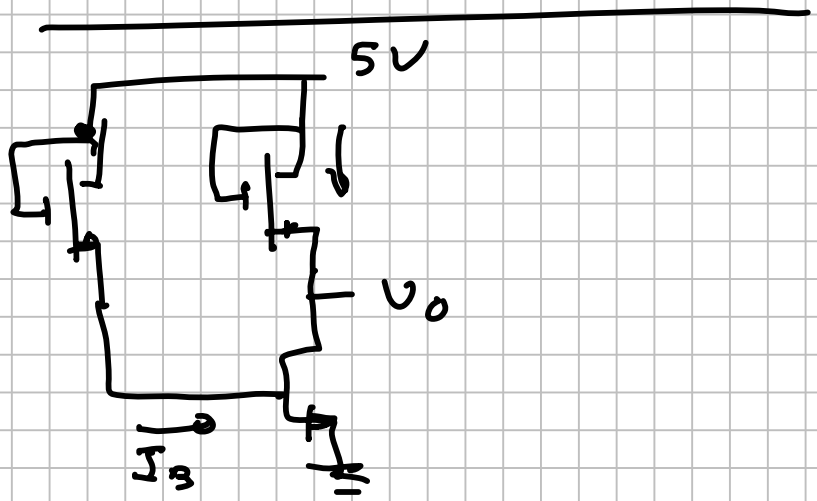


$5V - \frac{1.4V}{5K} \cdot 2K = 4.34V$

$V_o \simeq .4V$



$I_B = I_S A e^{\frac{V_{BE}}{V_T}}$



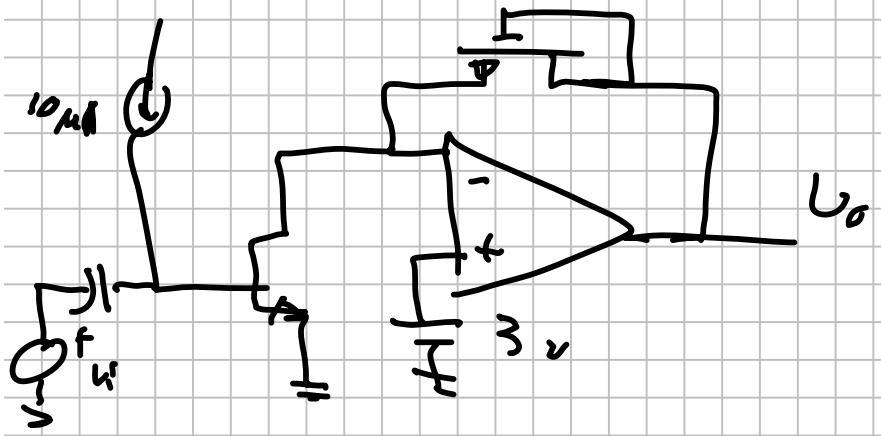
$I_C = \frac{\mu C_{ox} W_2}{2L_2} (5 - V_o - V_T)^2$

$V_o = 2.68V$

$I_B = \frac{\mu C_{ox} W_1}{2L_1} (5 - .6 - V_T)^2 \simeq .16\mu A$

$I_C = \beta I_B = 1.6 mA$

$I_C = I_S A e^{\frac{V_{BE}}{V_T}}$ can not assume $V_{BE} = .6V$



$$V_o = 3v + V_{GS}$$

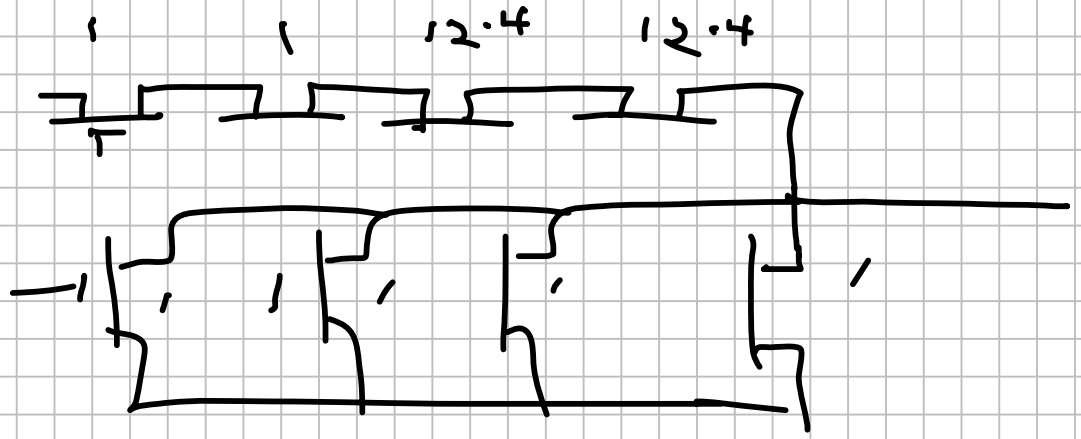
$$I_D = \beta\, 10\mu A = 1mA$$

$$1mA = \frac{\mu C_{ox} W}{2L}(V_{GS} - V_t)^2$$

$$V_{GS} = 2.5v$$

$$\therefore \quad V_o = 5.5v$$

4.



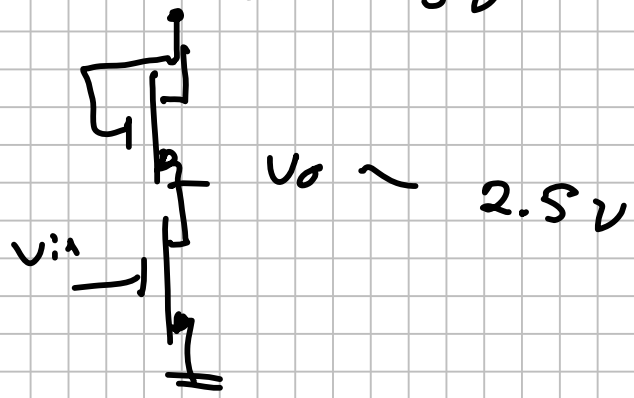
$\frac{K+3}{4}$

$$wc\ pa = R_{PD}(98)(8)\left(\frac{7}{4}\right)C_{REF}$$

$$pa = R_{PD}(8)\frac{7}{4}C_{REF}$$

$$\left(\frac{1}{2}\right)\left(\frac{4\,R_{EF}}{4}(8)\frac{7}{4}C_{REF}\right)$$

$V_{DD} = 5V$



$$\frac{\mu C_{ox} W_1}{2L_1}\left(V_{in} - V_T\right)^2 = \frac{\mu C_{ox} W_2}{2L_2}\left(5 - V_o - V_T\right)^2$$

$$V_{in} = V_T + \frac{L_1}{L_2}\left(V_{DD} - V_{to} - V_T\right)$$