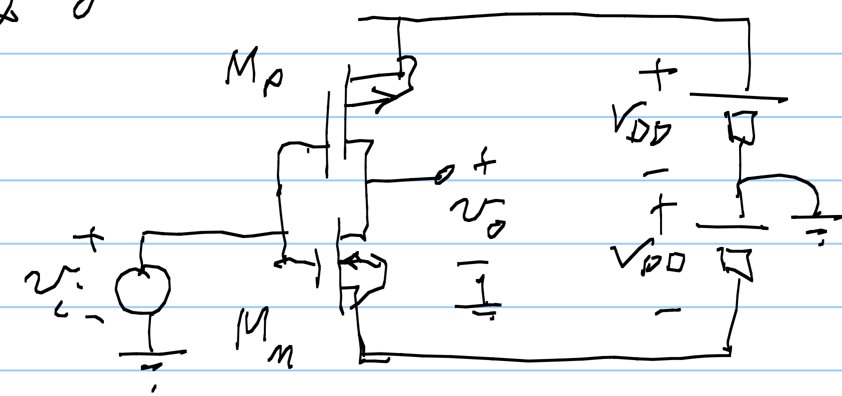
Note Title 10/28/2014

EE303H
10/28/14

Midterm Th open book

ternary gate

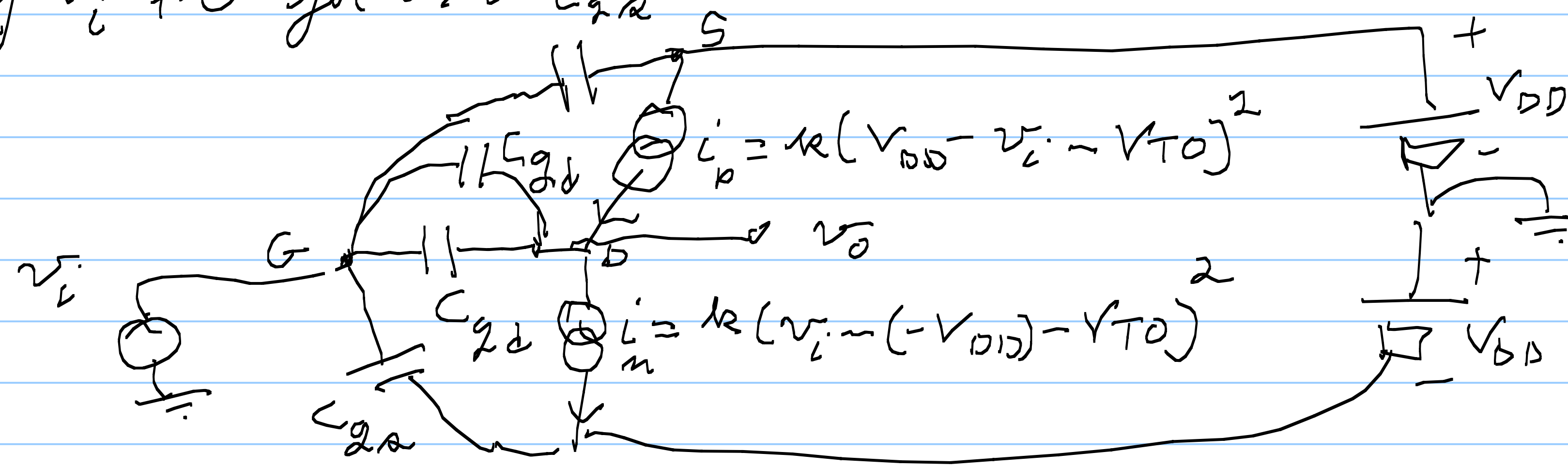


$M_p = \overline{M}_n$

assume @ $t \le 0_-$, $v_i = 0$, $v_o = 0$

if M_n & M_p are enhancement mode, $V_{TO_n} > 0$
$\Rightarrow M_n$ & M_p are in saturation at $t = 0$

if $v_i \neq 0$ for $t > 0$



$$i_p = k(V_{DD} - v_i - V_{TO})^2$$

$$i_n = k(v_i - (-V_{DD}) - V_{TO})^2$$

$$i_{C_{gd}} = 2C_{gd}\frac{d}{dt}(v_o - v_i) = i_p - i_n$$

$$= k\left((V_{DD} - V_{TO})^2 - 2(V_{DD} - V_{TO})v_i + v_i^2\right)$$

$$- k\left((V_{DD} - V_{TO})^2 + 2(V_{DD} - V_{TO})v_i + v_i^3\right)$$

$$= k\left[-2(V_{DD} - V_{TO})v_i - 2(V_{DD} - V_{TO})v_i\right]$$

$$= -4k(V_{DD} - V_{TO})v_i$$

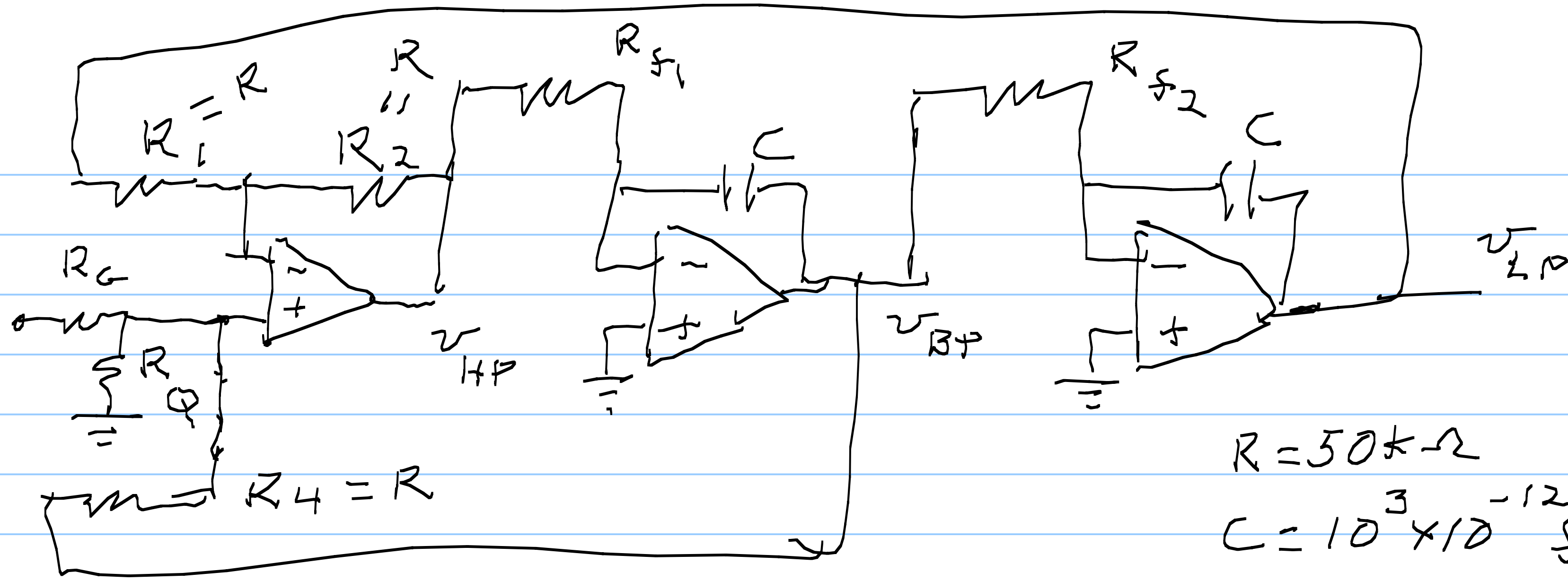
$$2C_{gd}\frac{dv_O}{dt} = 2C_{gd}\frac{dv_i}{dt} - 4k(V_{DD}-V_{TO})v_i$$

TI UAF 42

Low pass $\quad \frac{V_O}{V_i}(s) = \frac{A_{LP}\,\omega_n^2}{s^2 + \frac{\omega_n}{Q}s + \omega_n^2}$

Design for noninverting pole-pair low pass

$$\omega_n = 5\times10^3, \quad Q = 50$$



$R = 50k\Omega$

$C = 10^{3} \times 10^{-12}$ fd

$$A_{LP} = \frac{2}{R_G\left(\frac{1}{R_G} + \frac{1}{R_Q} + \frac{1}{R_4}\right)} = \frac{2/R_G}{\frac{1}{R_{11}} + 1/R_4} = \frac{2R_4 R_{11}}{R_4 + R_{11}} \cdot \frac{1}{R_G}$$

$$\omega_n^2 = \frac{1}{R_{f_1} R_{f_2} C^2} = 5^2 \times 10^6 = 25 \times 10^6 = \frac{1}{R_{f_1} R_{f_2} \times 10^6 \times 10^{-24}}$$

$$\Rightarrow R_{f_1} R_{f_2} = \frac{10^{12}}{25} = 4 \times 10^{10}$$

$$Q = \frac{1 + R_4/R_{11}}{2}\left[\frac{R_{f_1}}{R_{f_2}}\right]^{1/2} = 50 \qquad R_{11} = \frac{R_G R_Q}{R_G + R_Q}$$

$$\frac{R_{f_1}}{R_{f_2}} = \frac{25 \times 10^2 \times 4}{\left(1 + (R_4/R_{11})\right)^2} = \frac{10^4}{\left(1 + \left(\frac{R_4}{R_{11}}\right)\right)^2}$$

$$A_{LP} = 2\,\frac{R_4}{R_G} \cdot \frac{1}{1 + R_4/R_{11}} \quad ; \quad \text{choose } R_4 = R_G$$

$$= \frac{2}{1 + R_4/R_{11}}$$

$$R_{f_1} = \frac{1}{R_{f_2}} \times 4 \times 10^{10} \quad \& \quad \frac{1}{R_{f_2}^2} \times 4 \times 10^{10} = \frac{10^4}{\left(1 + \frac{R_4}{R_{11}}\right)^2}$$

$$R_{f_2}^2 = \frac{4 \times 10^{10}}{10^4} \times \left(1 + \frac{R_4}{R_{11}}\right)^2$$

$$R_{f_2} = 2\times10^3\left(1+\frac{R_4}{R_{11}}\right)$$

$$= 2\times10^3(1+2)$$

$$= 4\ K\Omega$$

if $R_{11} = \dfrac{R_G R_Q}{R_G + R_Q} = \dfrac{1}{2}R$

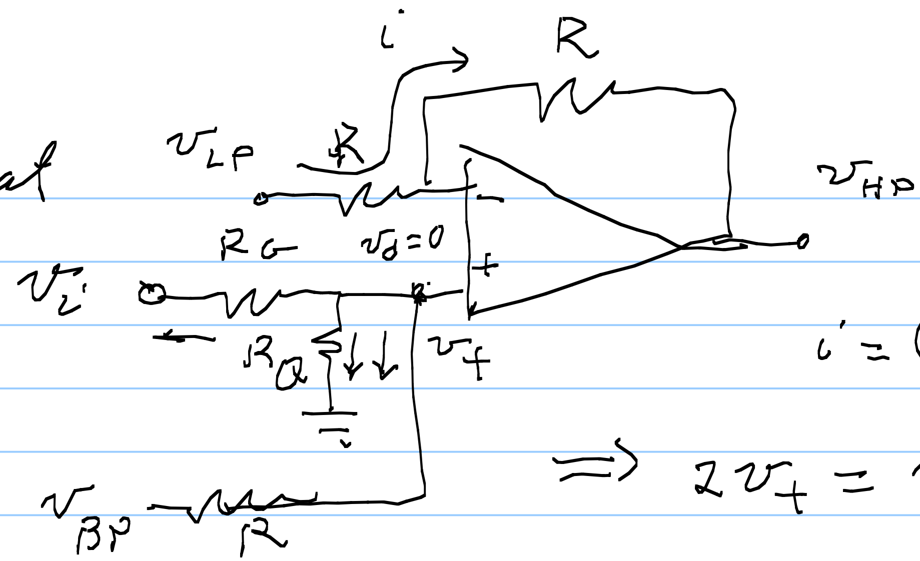
$\Rightarrow R_G = R_Q$

$$R_{f_1} = \frac{4}{4\times10^3}\times10^6 = 1\times10^3 = 1\,K\Omega$$

$A_{LP} = \dfrac{2}{1+2} = 2/3$ gain @ DC for all resistors equal

$$\frac{V_o}{V_i} = \frac{\frac{2}{3}\times(5\times10^3)^2}{s^2 + \frac{5\times10^3}{50}s + (5\times10^3)^2}$$

look at



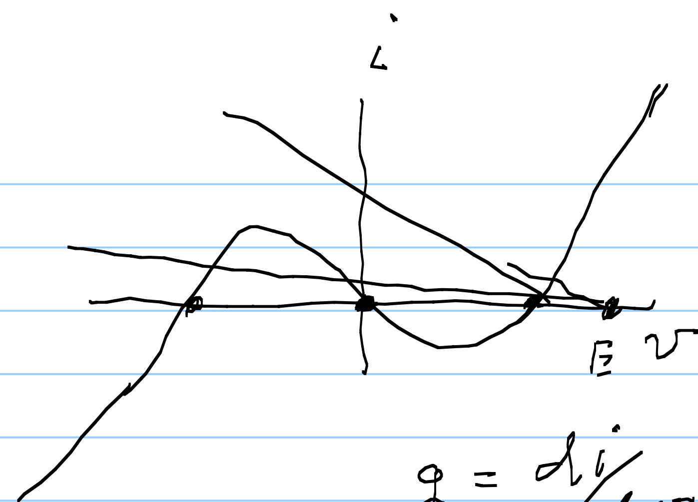
$i = (v_{LP} - v_+)G = G(v_+ - v_{HP})$

$\Rightarrow 2v_+ = v_{LP} + v_{HP}$

$$(v_+ - v_i)G_G + v_+ G_Q + (v_+ - v_{BP})G = 0$$

solve for $v_+ \Rightarrow \dfrac{v_{LP} + v_{HP}}{2}$ gives v_i in terms of v_{LP}, v_{HP}, v_{LP}

small signal diode



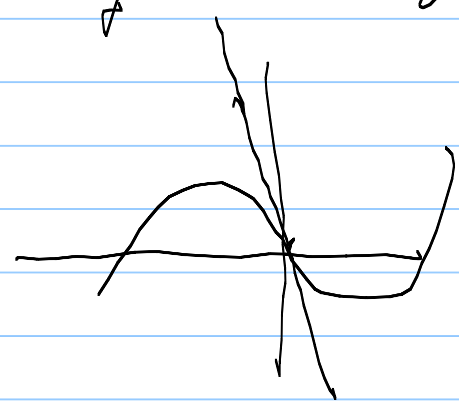
$i = I(v-1)\cdot v\cdot(v+1)$

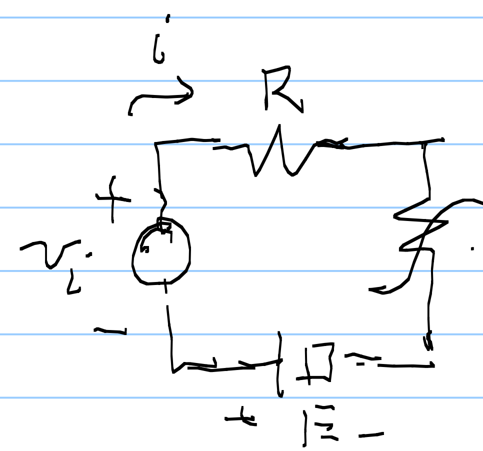
g @ $v=0$

$g = di/dv = I\{v\cdot(v+1) + (v-1)(v+1) + (v-1)v\}$

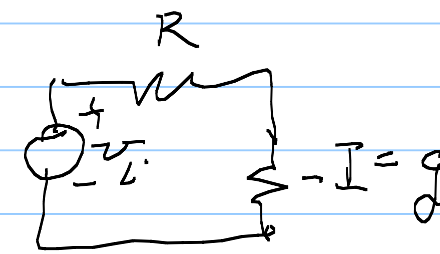
$g\big|_{v=0} = -I$

if $E=0$





⇒



if $E=0$

$i = v_i\left[\dfrac{1}{R - \frac{1}{I}}\right]$

⇒ can give power if $R < \frac{1}{I}$ then the current flows into the source