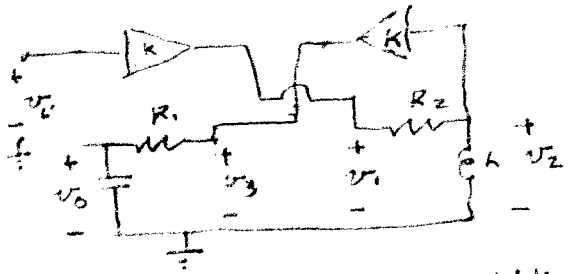
Solutions EE303 Class final S11 KWM. P.1 05/17/11

#1



$v_1 = K v_i$, $v_2 = \frac{sL}{sL+R_2} v_1 + \frac{sLK}{sL+R_2} v_i$

$v_3 = K v_2 = \frac{sLK^2}{sL+R_2} v_i$, $v_0 = \frac{1/sC}{\frac{1}{sC}+R_1} v_3 = \frac{1}{1+sR_1C} v_3$

$= \frac{1}{sR_1C+1} \cdot \frac{sLK^2}{sL+R_2} \cdot v_i$

a) $\therefore T(s) = \frac{sLK^2}{(sR_1C+1)(sL+R_2)} = \frac{(K^2/R_1C)\cdot s}{(s+(1/R_1C))(s+(R_2/L))} = \frac{v_0}{v_i}$; poles: $s = -1/R_1C,\ -R_2/L$; zeros: $s = 0, \infty$

For $v_0 = v_i$; $T(s) = 1 \Rightarrow v_0 = T(s) v_0 \Rightarrow \left(1 - \frac{sLK^2}{(sR_1C+1)(sL+R_2)}\right) v_0 = 0$

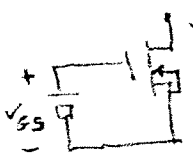
$\Rightarrow (sR_1C+1)(sL+R_2) - sLK^2 = 0 \quad (\text{or } s=\infty)$

$\equiv s^2 R_1CL + (R_1CR_2 + L - LK^2)s + R_2 = 0$

For an oscillator $s = j\omega_0 \Rightarrow -\omega_0^2 R_1CL + R_2 = 0$ & $j\omega_0(R_1CR_2 + L - LK^2) = 0$

$\Rightarrow \omega_0 = \pm\sqrt{\frac{R_2}{R_1}\cdot\frac{1}{LC}}$, $K^2 = 1 + R_1R_2\frac{C}{L} \equiv K = \pm\sqrt{1 + R_1R_2\frac{C}{L}}$

#2.



as a current source the transistor should be in saturation

$\Rightarrow I_D = \beta(V_{GS} - VTO)^2(1 + \lambda V_{DS})$; $\beta = \frac{KP}{2}\frac{W}{L}$; as β, I_D, λ, V_{DS} all known, find V_{GS}

$\Rightarrow V_{GS} = VTO + \sqrt{\frac{I_D}{\beta(1+\lambda V_{DS})}}$

for 4007: $\beta = \frac{20.54\times10^{-6}}{2} \times \frac{144\times10^{-6}}{8\times10^{-6}} = 184.86\times10^{-6}$, $VTO = 1.3$, $\lambda = 15\times10^{-3}$, $V_{DS} = 5$

$\therefore V_{GS}\big|_{\lambda=0} = 1.3 + \sqrt{\frac{2\times10^{-3}}{184.86\times10^{-6}}}$ if $\lambda = 0$ $= 4.589 = 1.3 + 3.289$

$V_{GS}\big|_{\lambda} = 1.3 + \sqrt{\frac{2\times10^{-3}}{184.86\times10^{-6}(1+15\times10^{-3})}}$ if $\lambda = 15\times10^{-3}$ $= 4.472 = 1.3 + 3.172$

so if λ is ignored V_{GS} will be slightly too big by 0.117V out of 4.5V

Note $V_{DS} - VTO < 3.3 < V_{DS} = 5 \Rightarrow$ saturation, as a check