04/04/12 - 05/? RWN

Midterm Makeup Exam 303 S2012

#1. Formulas as in Midterm

$$V_{BE} = V_T \ln\left(\frac{I_0 \times \left(\frac{\beta+1}{\beta}\right)}{I_S}\right) = 26\times10^{-3}\ln\left(\frac{6\times10^{-3}\times\left(\frac{121}{120}\right)}{3\times10^{-16}}\right) = 26\times10^{-3}\ln\left(2\times10^{13}\times1.0083\ldots\right)$$

$$= 26\times10^{-3}\times\left[\ln 10^{13} + \ln 2.017\ldots\right] = 26\times10^{-3}\times\left[6\ln100 + \ln10 + 0.77319\right] = 0.778 + 0.0201$$

$$= 0.798$$

$$I_i = \left(\frac{\beta+2}{\beta}\right)I_0 = \frac{122}{120}\times6\times10^{-3} = 6.1\times10^{-3}\,A$$

$$R = \frac{V_{CC}-V_{BE}}{I_i} = \frac{6-0.798}{6.1\times10^{-3}} = 0.853\times10^{3} = 853\,\Omega$$

#2. Equivalent circuit & formulas as in Midterm

$$I_{D_m} = \frac{KP_n}{2}\frac{W}{L}(V_{GS_m}-V_{TO_m})^2(1+\lambda_m V_{DS_m}) = \frac{5}{2}\times10^{-5}\cdot\frac{8\times10^{-6}}{8\times10^{-6}}\cdot(5-1.1)^2(1+0.12\times5) = 2.5\times10^{-5}\times15.21\times1.6$$

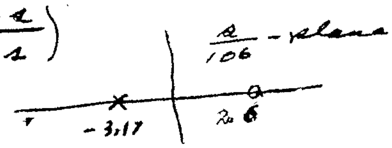
$$= 60.84\times10^{-5} = 0.608\,mA$$

$$g_m = \frac{2I_{D_m}}{(V_{GS_m}-V_{TO_m})} = \frac{2\times0.608\times10^{-3}}{3.9} = 0.312\times10^{-3}\,℧\ ;\ g_o = \lambda I_{D_m} = 0.073\times10^{-3}$$

$$\frac{v_o}{v_i} = -\frac{g_m}{g_o}\left(\frac{1-(C_{gd}/g_m)s}{1+\left(\frac{2C_{gd}+C}{2g_o}\right)s}\right) = -\frac{2}{\lambda(V_{GS_m}-V_{TO_m})}\left(\frac{1-(12\times10^{-12}/0.312\times10^{-3})s}{1+\left(\frac{(24+22)\times10^{-12}}{2\times0.073\times10^{-3}}\right)s}\right)$$

$$= -4.27\left(\frac{1-38.46\times10^{-8}s}{1+31.506\times10^{-8}s}\right) = -5.21\left(\frac{2.6\times10^{6}-s}{3.17\times10^{6}+s}\right)$$

zero @ $s = 2.6\times10^{6}$, pole @ $s = -3.17\times10^{6}$



#3. $L s \Rightarrow 1/Cs$, $C_1 s \Rightarrow \frac{1}{L_1 s}$, $C_2 s \Rightarrow \frac{1}{L_2 s}$ $\Rightarrow$

$$\frac{V_1}{V_0}(s) = \frac{1}{\frac{R}{L_1L_2Cs^3} + \frac{1}{L_2Cs^2} + \left(\frac{1}{L_1}+\frac{1}{L_2}\right)\frac{R}{s} + 1}$$

$$= \frac{L_1L_2Cs^3}{L_1L_2Cs^3 + (L_2+L_1)CRs^2 + L_1 s + R}$$

as in midterm

$$\frac{V_o}{V_i}(s) = \frac{-(R_f/R_i)}{1+(R_f/R_i)\frac{V_1}{V_0}(s)} = \frac{-K\left[L_1L_2Cs^3 + (L_2+L_1)CRs^2 + L_1s + R\right]}{(KL_1L_2C + L_1L_2C)s^3 + (L_2+L_1)CRs^2 + L_1s + R}$$

set denominator $= 0$ @ $s = j\omega_o$ $\Rightarrow$ Re & Im separately 0:

Re: $-(L_1+L_2)CR\,\omega_o^2 + R = 0$

Im: $\left[-(K+1)L_1L_2C\,\omega_o^2 + L_1\right]\omega_o = 0.\ (\omega_o \neq 0)$

Re $\Rightarrow$ $\omega_o^2 = \frac{1}{(L_1+L_2)C}$

$\Rightarrow$ Im $\Rightarrow$ $(K+1)\cdot\frac{L_1L_2}{L_1+L_2} = L_1 \Rightarrow K+1 = 1+\frac{L_2}{L_1} \Rightarrow K = \frac{R_f}{R_i} = \frac{L_2}{L_1}$

poles are @ $s_{1,2} = \pm j\omega_o$, and $s_0 = -\sigma_0$ where

$$(s^2+\omega_o^2)(s+\sigma_0) = s^3 + \frac{(L_1+L_2)CR}{(K+1)L_1L_2C}s^2 + \frac{L_1}{(K+1)L_1L_2C}s + \frac{R}{(K+1)L_1L_2C}$$

$$\Rightarrow \sigma_0 = \frac{R}{(K+1)L_1L_2C}\times\frac{1}{\omega_o^2} = \frac{R}{L_1(L_1+L_2)}\cdot\frac{1}{\frac{1}{(L_1+L_2)C}} = \frac{RC}{L_1} \Rightarrow s_0 = -\frac{RC}{L_1}$$

note: the "series" capacitor of the original is here a series inductor, $L_s = L_1 + L_2$ & now $\omega_o^2 = \frac{1}{CL_s}$