EHB 335E - HOMEWORK V - SOLUTIONS - ALICAN GAGLAR

① If $V_{in}\uparrow$, to provide same current value, $V_{D1}\uparrow$, $V_{G2}\uparrow$ $\Rightarrow$ $V_{out}\uparrow$

By feedback circuit $\Rightarrow$ $V_{D1}\downarrow$, $V_{G2}\downarrow$ $\Rightarrow$ $V_{out}\downarrow$ $\Rightarrow$ It is a negative feedback.

② $\tan^{-1}\frac{f}{10^5} + \tan^{-1}\frac{f}{3,16.10^5} + \tan^{-1}\frac{f}{10^6} = 135^\circ$ $\quad f \cong 3,16.10^5\ Hz$

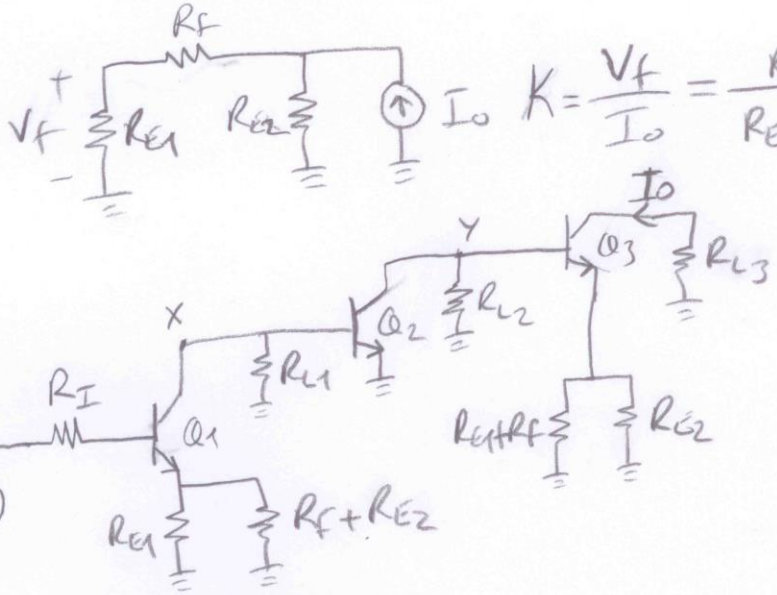
$$A(j\omega) = \frac{10^4}{\left(\frac{j\omega}{10^5}+1\right)\left(\frac{j\omega}{3,16.10^5}+1\right)\left(\frac{j\omega}{10^6}+1\right)}, \quad \text{when } f = 3,16.10^5\ Hz$$

$\Rightarrow |A| \cong 66\ dB$

So, $20\log\left(\frac{1}{\beta}\right) = 66\ dB \quad \Rightarrow \beta = 5.10^{-4}$

$$A_f = \frac{10^4}{1+5.10^{-4}.10^4} = 1667\ V/V \text{ or } 64,4\ dB$$

③ The amplifier is a transconductance amplifier. So, the feedback topology should be series-series.



$$K = \frac{V_f}{I_o} = \frac{R_{E2}.R_{E1}}{R_{E1}+R_{E2}+R_F}$$

$$\frac{I_o}{V_I} = A_o = \frac{V_x}{V_I}.\frac{V_y}{V_x}.\frac{I_o}{V_y}$$

$$\frac{V_x}{V_I} = \frac{-\beta(R_{L1}\,//\,r_{\pi 2})}{R_I + r_{\pi 1} + (\beta+1).R_{E1}\,//\,(R_F+R_{E2})}$$

$$\frac{V_y}{V_x} = -g_{m2}.R_{L2}\,//\left[r_{\pi 3} + (\beta+1)R_{E2}\,//\,(R_{E1}+R_F)\right]$$

$$\frac{I_o}{V_y} = \frac{g_{m3}}{1+g_{m3}.(R_{E2}\,//\,(R_{E1}+R_F))}$$

$$R_{in} = R_I + r_{\pi 1} + (\beta+1)\left(R_{E1}\,//\,(R_F+R_{E2})\right)$$

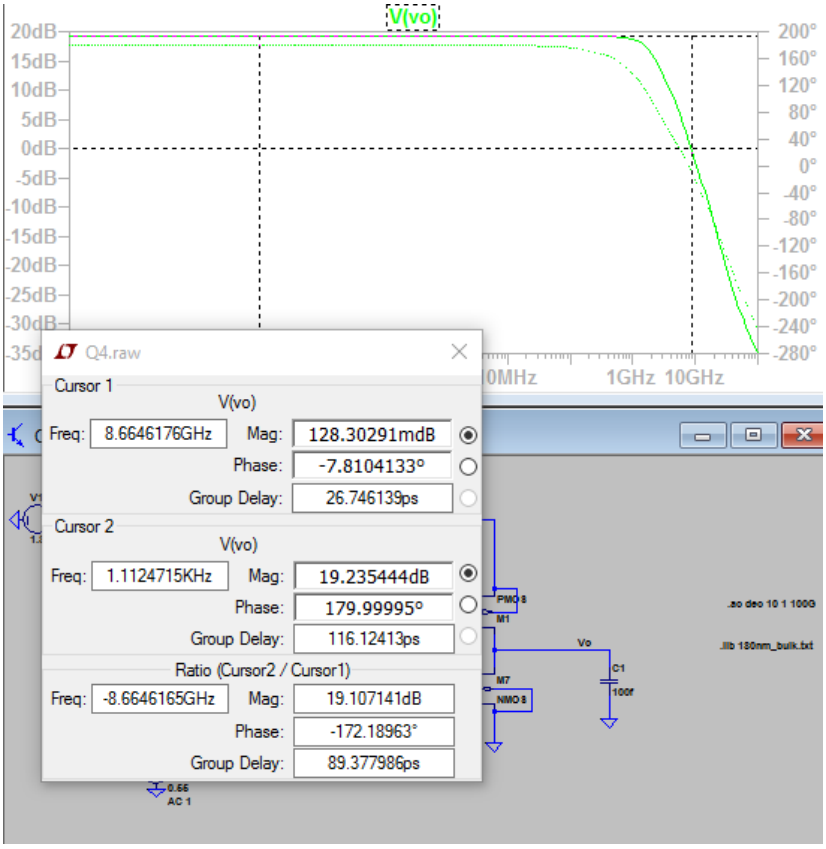
$R_{out} = \infty$

$$R_{if} = R_{in}(1+kA_o)$$

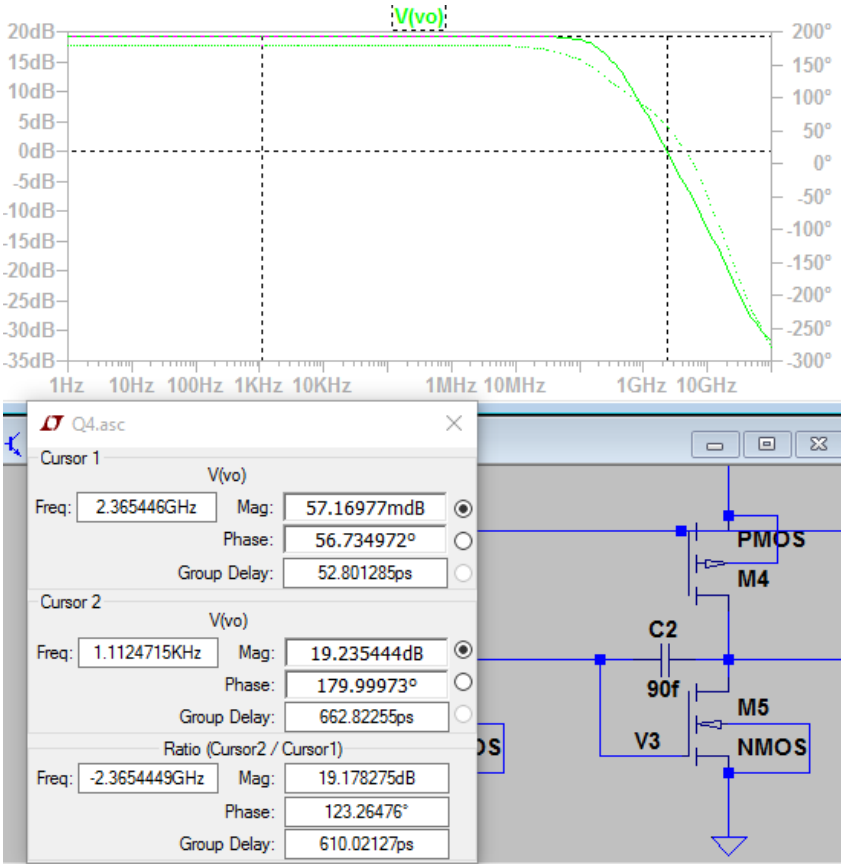
$$R_{of} = R_{out}(1+kA_o)$$

$$A_f = \frac{A_o}{1+KA_o}$$

4) With no compensation, the phase margin is about -8 degrees.



If a capacitance of 90 fF is applied between X and Y, phase margin reaches 55 degrees. Under this condition, unity-gain bandwidth is 2.36 GHz.



If a capacitance of 0.9pF is applied between X and the ground, phase margin reaches again 55 degrees. Under this condition, unity-gain bandwidth is 2 GHz.