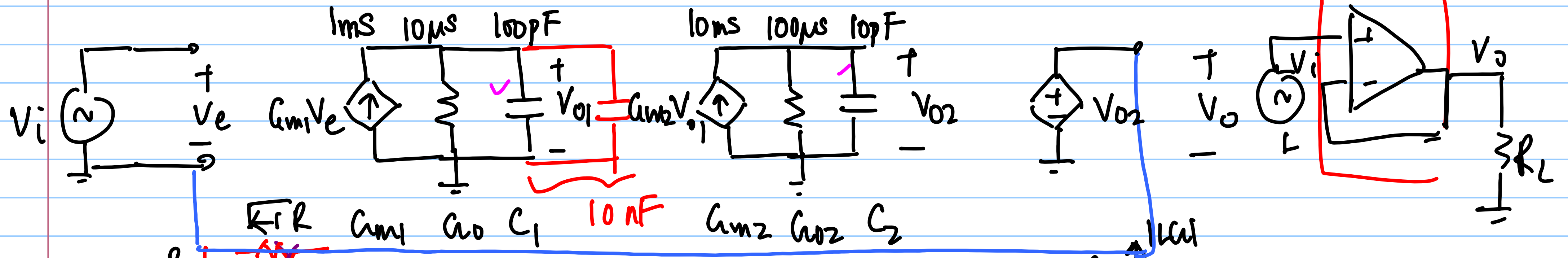
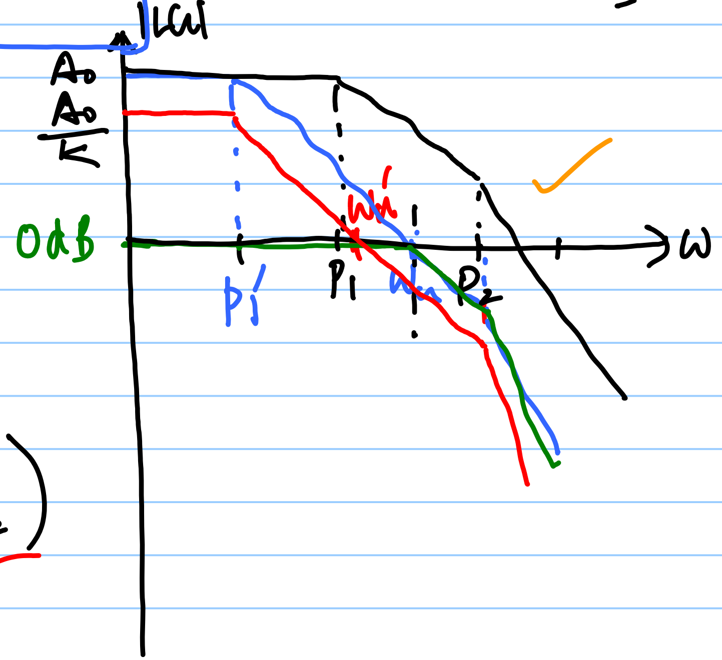
Lecture # 21



$$LG = \frac{V_o}{V_e} = \frac{\dfrac{G_{m1}}{G_{o1}}\,\dfrac{G_{m2}}{G_{o2}}}{\left(1+\dfrac{s}{p_1}\right)\left(1+\dfrac{s}{p_2}\right)}$$



"Unity Gain" Compensated.

$$\frac{V_o}{V_i} = \frac{LG}{1+LG} =$$

$$\left.\frac{V_o}{V_i}\right|_{\omega=0} = \frac{A_0}{1+A_0}$$

$$LG = \frac{A_0}{\left(1+\dfrac{s}{p_1'}\right)\left(1+\dfrac{s}{p_2}\right)}$$

$p_1' \ll p_2$

$p_2 \approx 4\omega_u \approx 4A_0 p_1$

$$\frac{V_o}{V_i} = \frac{1}{1+\frac{1}{L_a}} = \frac{1}{1+\frac{1}{A_0}\left(1+\frac{s}{p_1'}\right)\left(1+\frac{s}{p_2}\right)}$$

$$\left.\frac{V_o}{V_i}\right|_{\omega=\omega_u} = -3\,dB$$

$$D(s) = 1+\frac{1}{A_0}\left(1+s\left(\frac{1}{p_1'}+\frac{1}{p_2}\right)+\frac{s^2}{p_1'p_2}\right)$$

$$= \left(1+\frac{1}{A_0}\right)+\frac{s}{A_0}\left(\frac{1}{p_1'}+\frac{1}{p_2}\right)+\frac{s^2}{A_0 p_1' p_2}$$

$$= \left(1+\frac{1}{A_0}\right)\Bigg[\overset{c=1}{1}+\underbrace{\frac{s}{\cancel{A_0}\frac{(1+A_0)}{\cancel{A_0}}}\left(\frac{1}{p_1'}+\frac{1}{p_2}\right)}_{b}+\frac{s^2}{A_0\frac{(1+A_0)}{A_0}p_1'p_2}\Bigg]$$

$ax^2+bx+c=0$

x_1, x_2 are widely separated.

$x_1+x_2 = \frac{-b}{a}$ $\qquad x_1 \gg x_2$

$\Rightarrow x_1 \approx \frac{-b}{a}$

$x_1 x_2 = \frac{c}{a}$

$x_2 = -\frac{c}{b}$

$$p_1'' = -\frac{1}{\left(\frac{1}{p_1'}+\frac{1}{p_2}\right)/(1+A_0)} \approx -A_0 p_1'$$

$$p_2'' = \frac{-b}{a} = \frac{\left(\frac{1}{p_1'}+\frac{1}{p_2}\right)\frac{1}{(\cancel{1+A_0})}}{\frac{1}{(\cancel{1+A_0})(p_1'p_2)}}$$

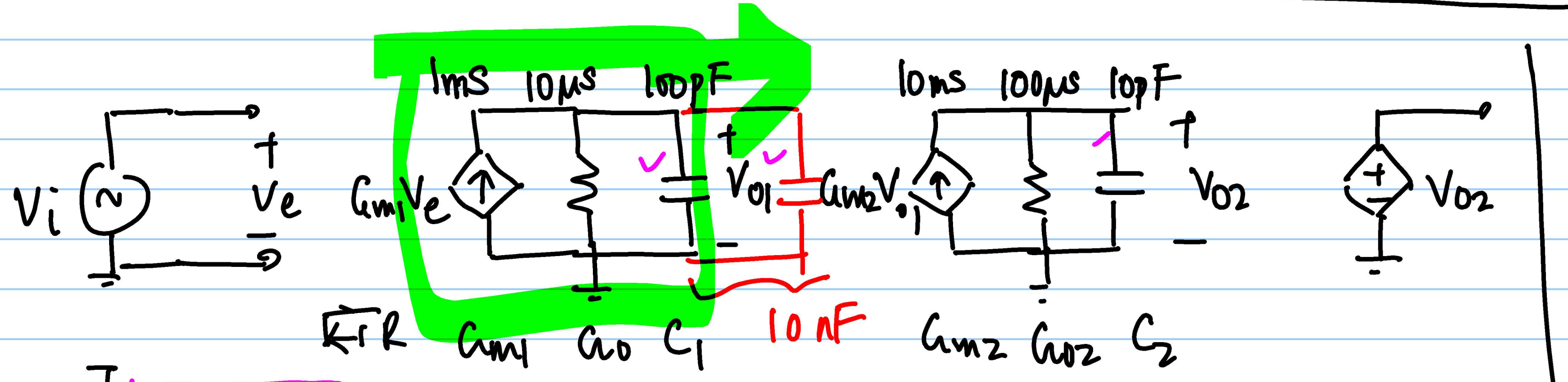
$\approx -p_2$

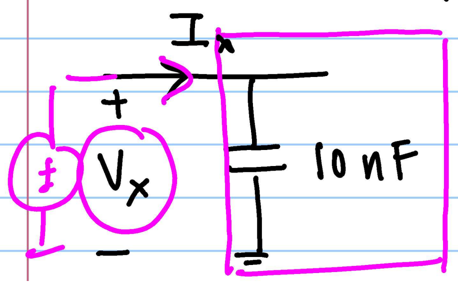
$$\frac{V_o}{V_i} = \frac{LG}{1+LG}$$

$1 + LG = 0 \Rightarrow$ poles of closed loop.

at $\omega = \omega_u$, $|LG(\omega_u)| = 1$

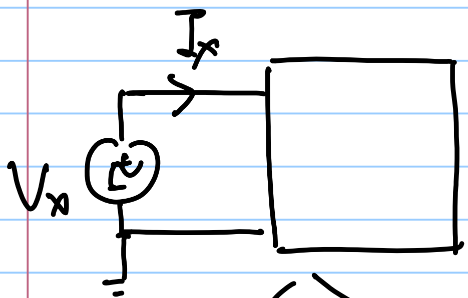
$\measuredangle LG = 180^\circ$



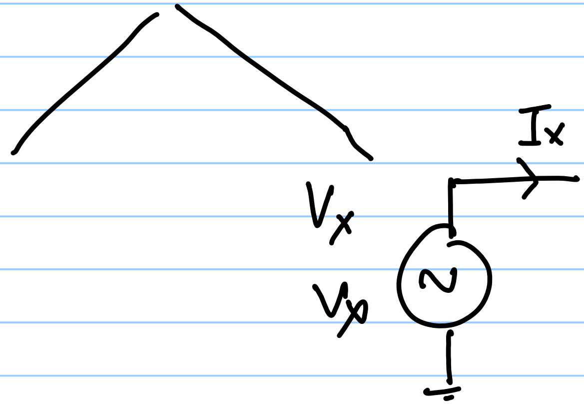


$$I_x = \frac{V_x}{1/sC_x} = V_x(sC_x) = V_x(s \cdot 10\,nF)$$

$I_x = V_x\,(s \cdot 10\,nF)$, $C_x = 10\,nF$



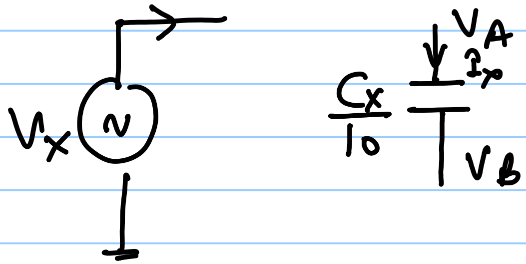
$I_x = V_x\,(sC_x)$



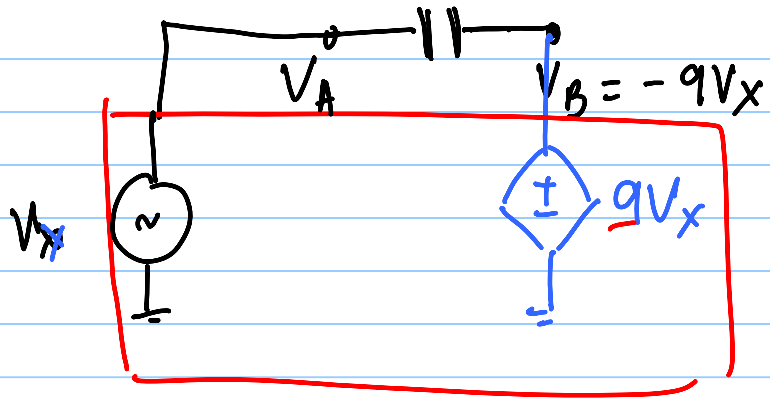
$$I_x = V_x(sC_x) = s\,C_x \cdot V_x$$

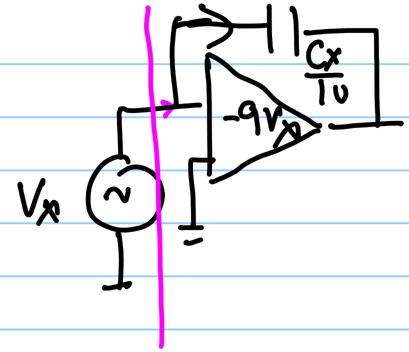
$$= s \cdot 10 \cdot C_x\,\frac{V_x}{10}$$

$$= s \cdot \frac{C_x}{10} \cdot 10V_x$$

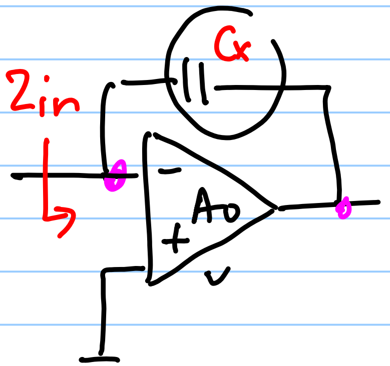


$V_A - V_B = 10\,V_x$

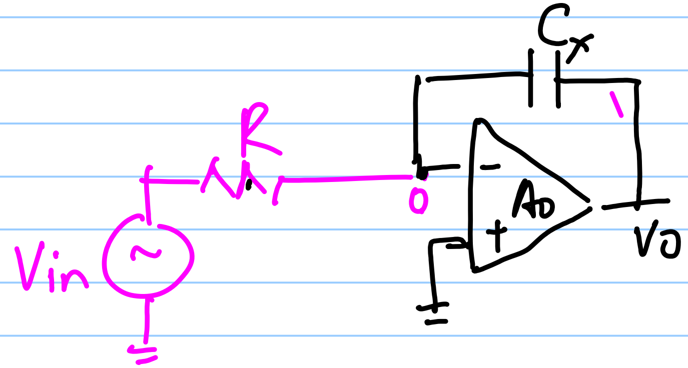




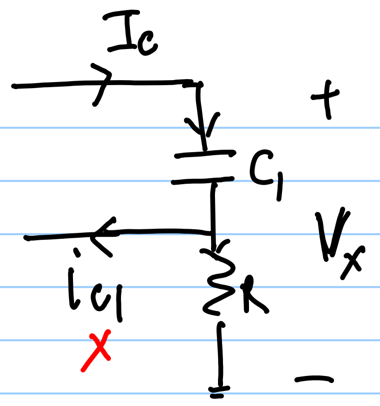
$$I_x = \left(V_x - (-9V_x)\right)\frac{1}{\frac{1}{sC_x/10}} = sC_xV_x$$



$$Z_{in} = \frac{1}{sC(1+A_0)}$$



$$\frac{V_o}{V_{in}} = -\frac{1}{sRC}$$



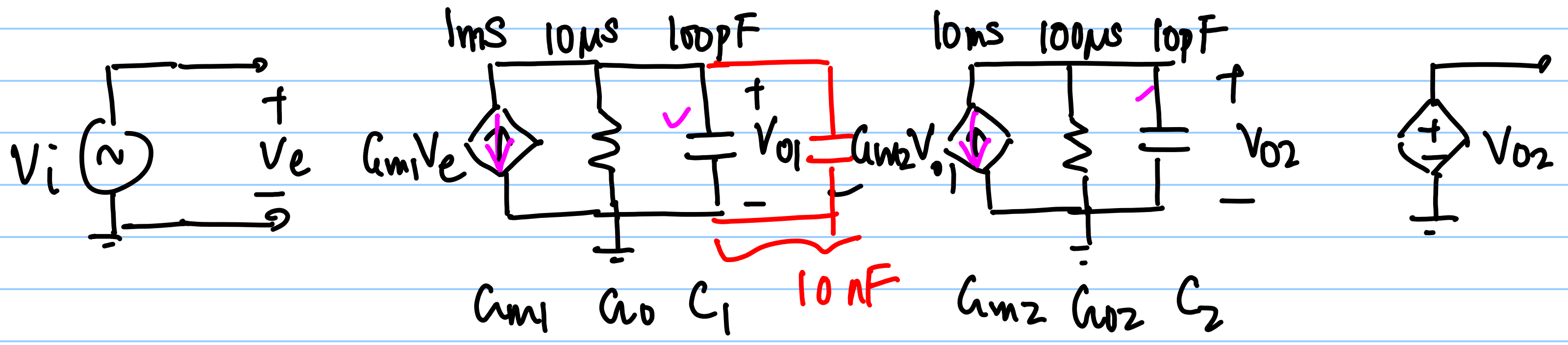
$$V_x = I_c \left(R + \frac{1}{sC_1}\right)$$

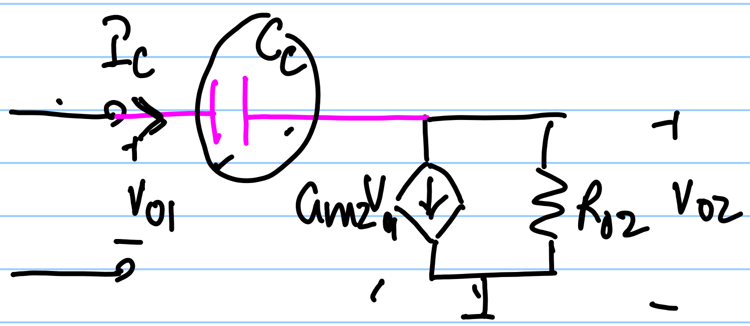
$$\frac{V_x}{I_c} = R + \frac{1}{sC_1} \checkmark$$

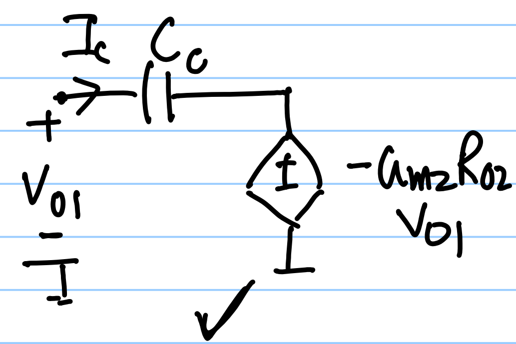
$$V_x = I_c \times \frac{1}{sC_1} + (I_c - i_{c1})R$$

$$= I_c \left[\frac{1}{sC} + \frac{(I_c - i_{c1})}{I_c} R \right]$$

$$\frac{V_x}{I_c} = \frac{1}{sC} + \left(1 - \frac{i_{c1}}{I_c}\right) R \checkmark$$

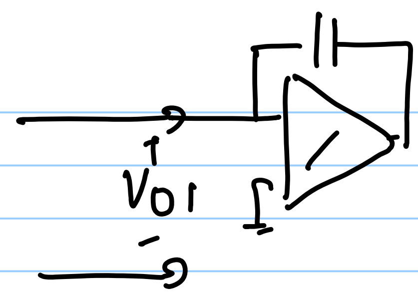






$$\frac{V_{02}}{V_{01}} = \underbrace{-G_{m2}R_{02}}_{A_0}$$

$$\frac{V_{01}}{I_c} = \frac{1}{sC_c(1+G_{m2}R_{02})}$$


+
V_{01}
-