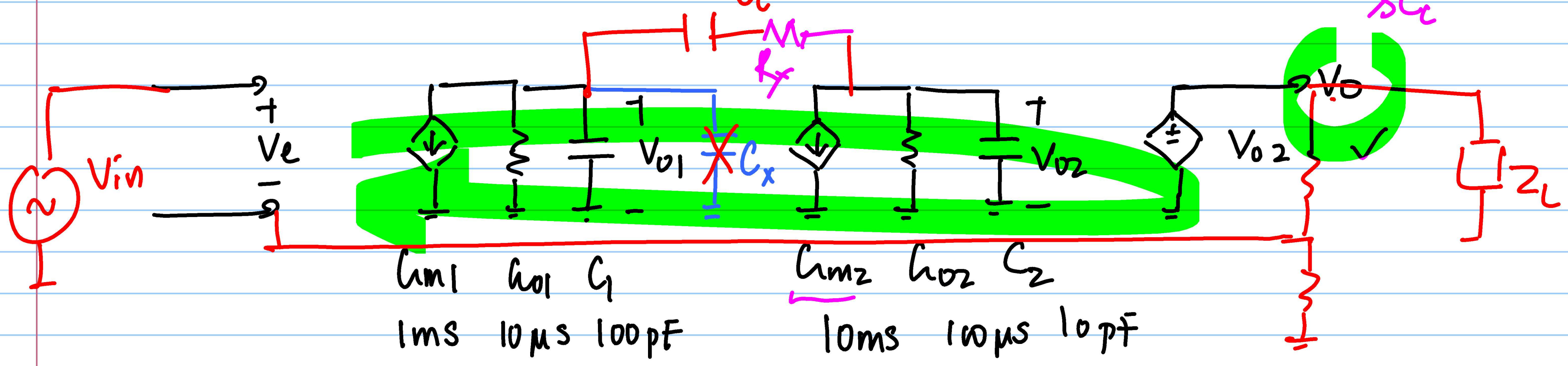
Lecture # 25

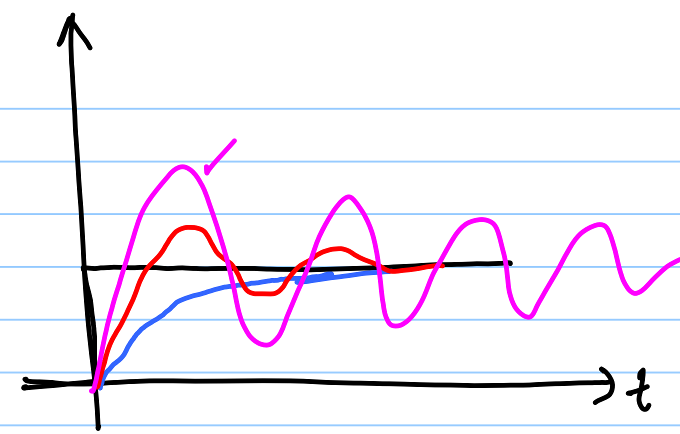
Two-stage Amp.

$$R_x + \frac{1}{sC_c} = \frac{1+sC_cR_x}{sC_c}$$



- Dominant pole compensation (ω_{u1}) $\quad C_x = 9.9\,nF$
- Miller compensation ($\omega_{u2} > \omega_{u1}$) $\quad C_c = 51.3\,pF$ ×
- $Z_1 = \dfrac{G_{m2}}{C_c} = 2\times 10^{8}$ rad/s.

$$L_a = \frac{A_0\left(1-\frac{s}{z_1}\right)}{\left(1+\frac{s}{p_1}\right)\left(1+\frac{s}{p_2}\right)}$$



$$\measuredangle L_a = -\tan^{-1}\left(\frac{\omega}{z_1}\right) - \tan^{-1}\left(\frac{\omega}{p_1}\right) - \tan^{-1}\left(\frac{\omega}{p_2}\right)$$

- ✓ $z_1 \gg \omega_u \Rightarrow \phi_m$ roughly same.
- Any other problem?

$$H(s) = \frac{(1+s/z_1)}{(1+s/p_1)}$$

$$u(t) \rightarrow \boxed{H(s)} \rightarrow v(t)$$

$$V(s) = H(s)\,U(s)$$

$$v(t) = \mathcal{L}^{-1}(V(s))$$

$$V(s) = \frac{1}{s}\,\frac{(1+s/z_1)}{(1+s/p_1)} = \frac{p_1}{z_1}\left[\frac{1}{s}\,\frac{(s+z_1)}{s+p_1}\right]$$

$$= \frac{p_1}{z_1}\left[\frac{z_1/p_1}{s} + \frac{(z_1-p_1)/-p_1}{s+p_1}\right]$$

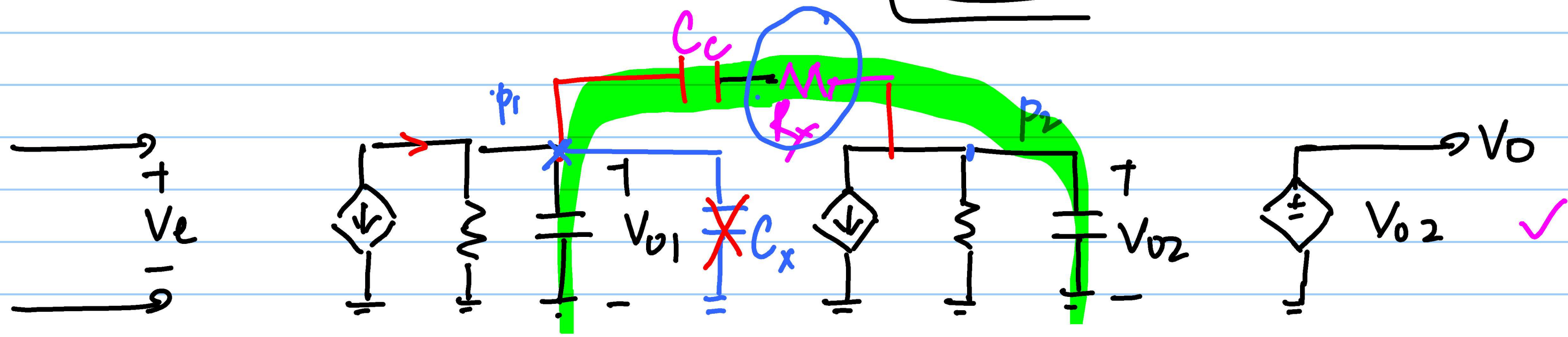
$$V(s) = \frac{1}{s} - \frac{1}{z_1}\frac{(z_1 - p_1)}{s+p_1}$$

$$= \frac{1}{s} - \frac{\left(1-\frac{p_1}{z_1}\right)}{s+p_1}$$

$$v(t) = \left[1 - \left(1-\frac{p_1}{z_1}\right)e^{-p_1 t}\right]u(t)$$

at $t=0$, $1 - \left(1-\frac{p_1}{z_1}\right) = \frac{p_1}{z_1}$

$u(t)$



$$R_x = \frac{1}{G_{m2}}$$

G_{m1}	G_{o1}	C_1	G_{m2}	G_{o2}	C_2
1mS	10μS	100pF	10mS	100μS	10pF

$$p_1 \approx \frac{G_{o1}}{C_1 + C_c\left(1+\frac{G_{m2}}{G_{o2}}\right)}$$

$$p_2 \approx \frac{G_{o2} + G_{m2}\frac{C_c}{C_c+C_1}}{C_2 + \frac{C_1 C_c}{C_1+C_c}}$$

$$p_3 \approx \frac{1}{R_x\left(\frac{1}{\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_c}}\right)} \quad \frac{1}{R_x C_c} \quad = \frac{1}{R_x C_2}$$

$$I = YV$$

$$\begin{bmatrix} -G_{m1}V_e \\ 0 \end{bmatrix} = \begin{bmatrix} G_{o1} + sC_1 + \frac{sC_c}{1+sC_cR_x} & -\frac{sC_c}{1+sC_cR_x} \\ G_{m2} - \frac{sC_c}{1+sC_cR_x} & G_{o2} + sC_2 + \frac{sC_c}{1+sC_cR_x} \end{bmatrix} \begin{bmatrix} V_{o1} \\ V_{o2} \end{bmatrix}$$

$$\frac{V_{o2}}{V_e} = \frac{G_{m2} s C_c R_x G_{m2} - sC_c}{D(s)} \times (\quad)$$

$$= \frac{G_{m2} - sC_c\,(1 - G_{m2}R_x)}{D(s)}$$

$$= \frac{G_{m2} \times \left[1 - \frac{sC_c}{G_{m2}} \underbrace{(1 - G_{m2}\cancel{R_x})}_{=0}\right]}{D(s)}$$

$$Z_1 = \frac{G_{m2}}{C_c\,(1 - G_{m2}R_x)}$$

$$= \frac{1}{C_c\left(\frac{1}{G_{m2}} - R_x\right)}$$

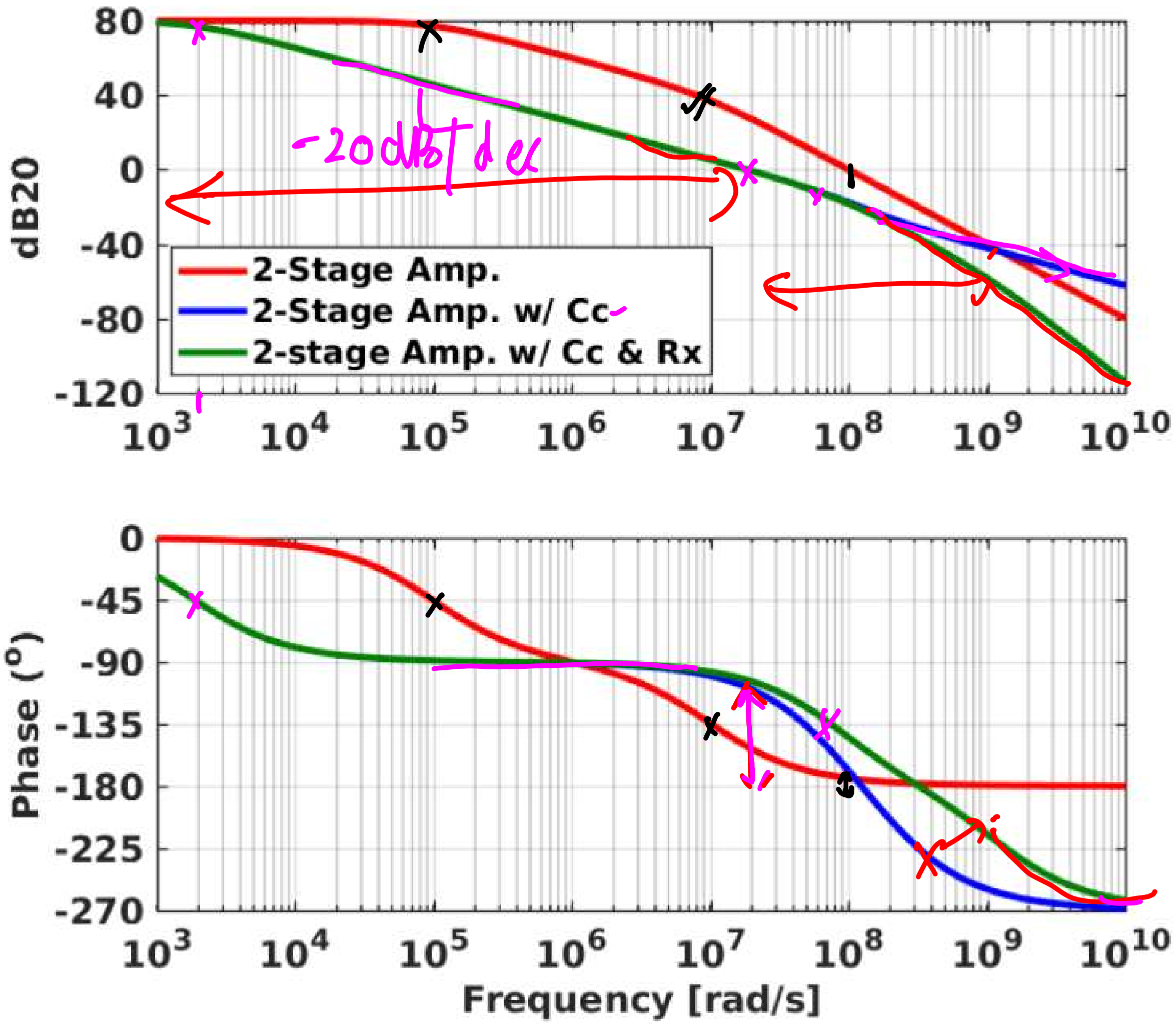
$R_x = 0$, $Z_1 = \frac{G_{m2}}{C_c}$

$R_x = \frac{1}{G_{m2}} \Rightarrow$ Eliminate zero

$R_x > \frac{1}{G_{m2}}$

$\Rightarrow$ L.H.P zero

$$Z_1 = -\frac{1}{R_x C_c}$$



$$LG(s) = \frac{A_0 \left(1 - \cancel{\frac{s}{z_1}}\right)}{\left(1+\frac{s}{p_1'}\right)\left(1+\frac{s}{p_2'}\right)\left(1+\frac{s}{p_3}\right)}$$

$20\log_{10}|LG|$

$$\left\{\begin{array}{l} tf \\ tfdata \\ freqs \end{array}\right.$$