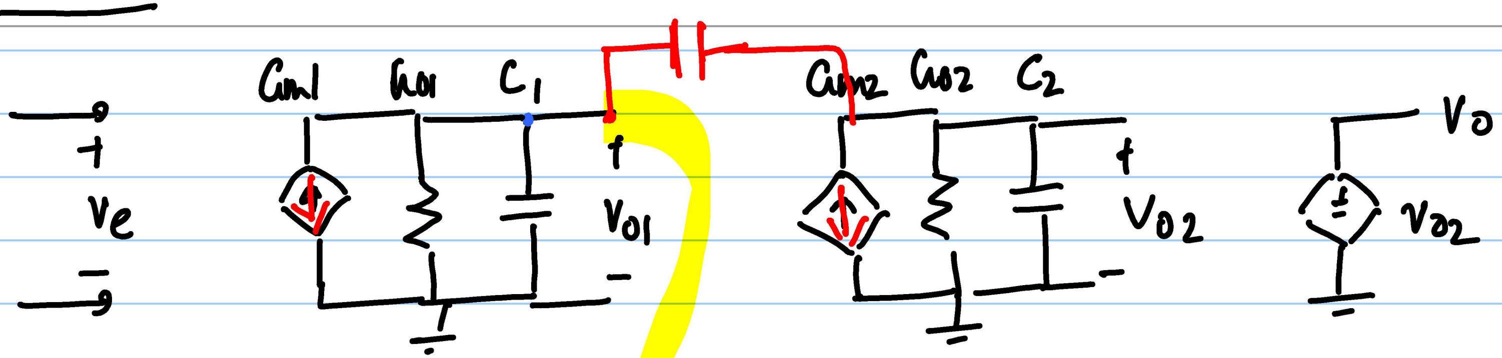
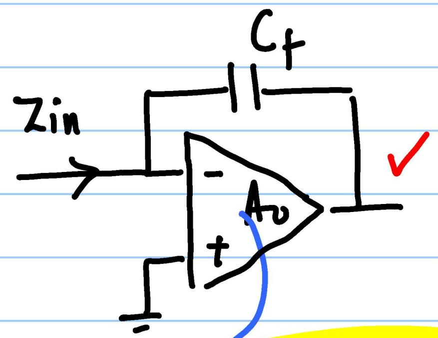
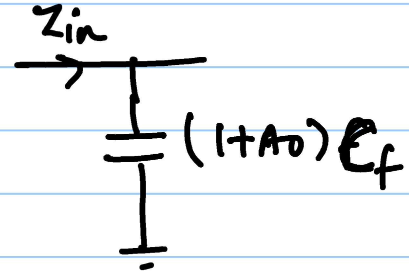
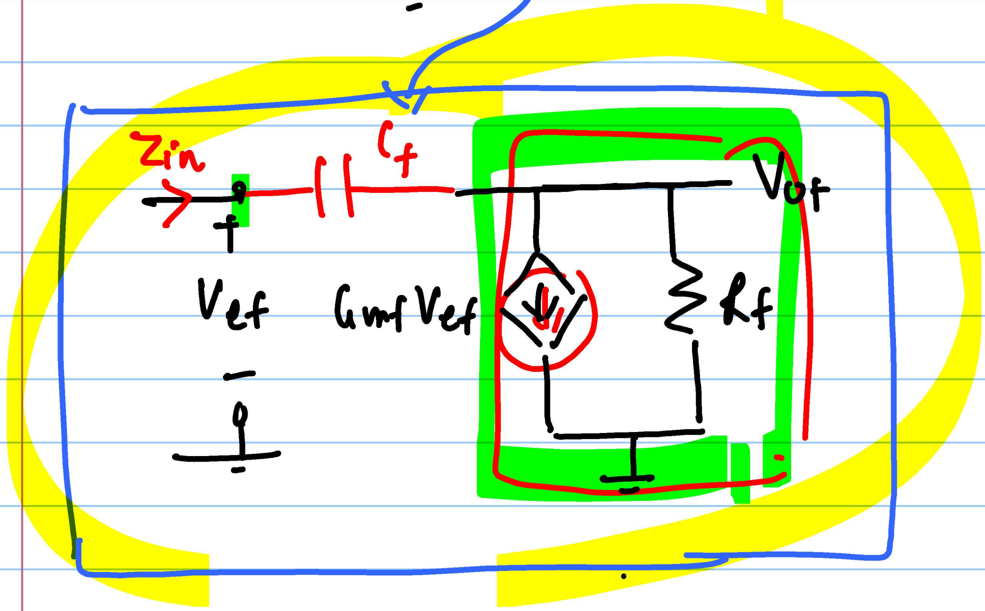
Lecture # 18

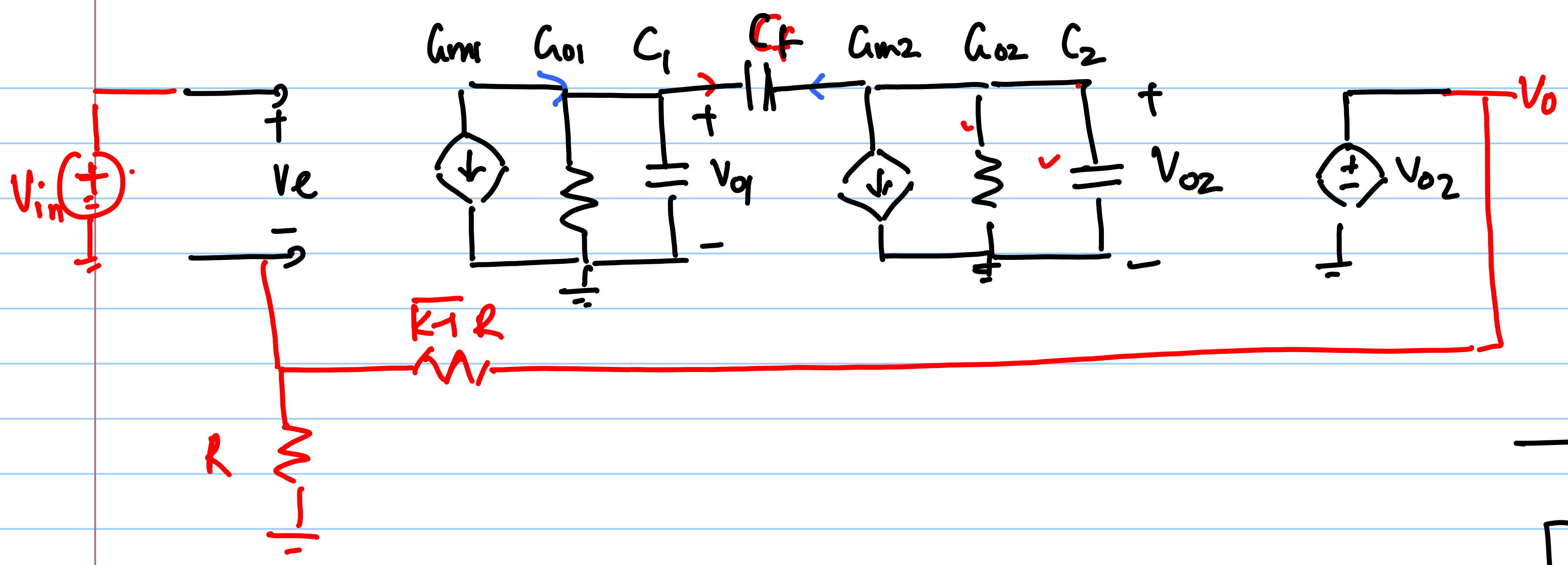


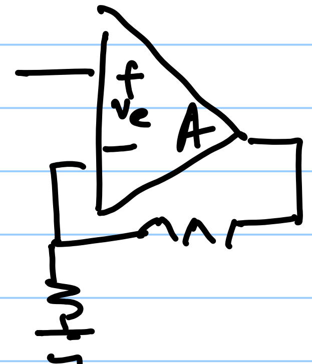


$$Z_{in} = \frac{1}{s(1+A_0)C_f} \equiv$$









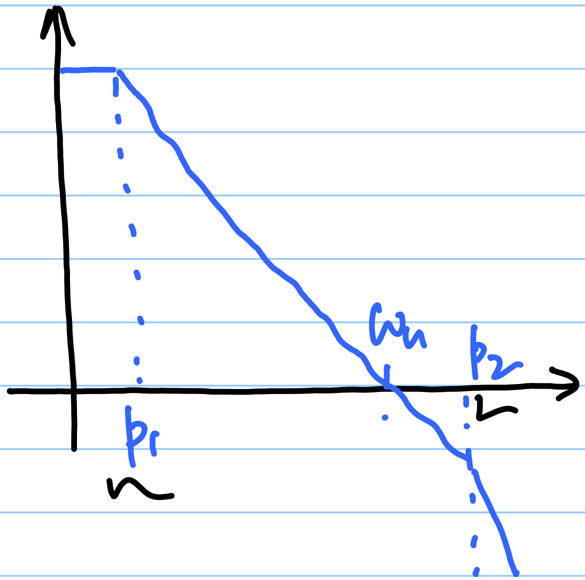
$$I = YV$$

$$\begin{bmatrix} -G_{m1}V_e \\ 0 \end{bmatrix} = \begin{bmatrix} G_{o1} + sC_1 + sC_f & -sC_f \\ G_{m2} - sC_f & G_{o2} + s(C_2 + C_f) \end{bmatrix} \begin{bmatrix} V_{o1} \\ V_{o2} \end{bmatrix}$$

$$\frac{V_{o2}}{V_e} = \frac{G_{m1}(G_{m2} - sC_f)}{s^2(C_1C_f + C_2C_f + C_1C_2) + s(C_fG_{m2} + C_f(G_{o1}+G_{o2}) + C_1G_{o2} + C_2G_{o1}) + G_{o1}G_{o2}}$$

$ax^2 + bx + c$

$$= \frac{A_{DC}(1+s/z_1)}{\left(1+\frac{s}{p_1}\right)\left(1+\frac{s}{p_2}\right)} = \frac{A_{DC}(1+s/z_1)}{1+s\left(\frac{1}{p_1}+\frac{1}{p_2}\right)+\frac{s^2}{p_1p_2}} = \frac{A_{DC}(1+s/z_1)}{s^2+(p_1+p_2)s+p_1p_2}$$



- p_1 and p_2 are widely separated.
- $ax^2+bx+c=0$

$x_1+x_2 = \frac{-b}{a}$, $x_1 \cdot x_2 = \frac{c}{a}$

if $x_1 \gg x_2 \Rightarrow x_1+x_2 \approx x_1 = \frac{-b}{a}$ ✓

$\Downarrow$

$x_2 = -\frac{c}{b} \Leftarrow \frac{-b}{a}\cdot x_2 = \frac{c}{a}$

$\boxed{x_1 \approx \frac{-b}{a}, \quad x_2 = \frac{-c}{b}}$

$$s_1 = -p_1 = -\frac{\left(C_f G_{m2} + C_f (G_{o1} + G_{o2}) + C_1 G_{o2} + C_2 G_{o1}\right)}{C_1 C_f + C_2 C_f + C_1 C_2} = \frac{-b}{a} \checkmark$$

$$s_2 = -p_2 = -\frac{G_{o1} G_{o2}}{\left(C_f G_{m2} + C_f (G_{o1} + G_{o2}) + C_1 G_{o2} + C_2 G_{o1}\right)} = \frac{-c}{b}$$

$$= -\frac{G_{o1}}{C_f \left\{ \boxed{\frac{G_{m2}}{G_{o2}}} + \frac{G_{o1}}{G_{o2}} + 1 \right\} + \left(C_2 \cdot \frac{G_{o1}}{G_{o2}} + C_f \right)} = \frac{G_{o1}}{\underbrace{C_f \left(1 + \frac{G_{m2}}{G_{o2}}\right)} + C_f \cdot \frac{G_{o1}}{G_{o2}} + C_2 \frac{G_{o1}}{G_{o2}} + C_1}$$

$$= -\frac{G_{o1} / C_1}{\frac{C_f}{C_1} \left\{ \frac{G_{m2}}{G_{o2}} + \frac{G_{o1}}{G_{o2}} + 1 \right\} + \left\{ \frac{C_2}{C_1} \frac{G_{o1}}{G_{o2}} + 1 \right\}} \checkmark$$

$$|p_2| > \frac{G_{o1}}{C_1}$$

$$< \frac{G_{o1}}{C_1}$$

$$p_1 = -\frac{\left(C_f G_{m2} + C_f(G_{o1}+G_{o2}) + C_1 G_{o2} + C_2 G_{o1}\right)}{C_1 C_f + C_2 C_f + C_1 C_2}$$

$$= -\frac{C_f\left(G_{m2} + G_{o2} + G_{o1}\right) + C_1 G_{o2} + C_2 G_{o1}}{C_1 C_f + C_2 (C_1 + C_f)}$$

$$= -\frac{\boxed{\frac{C_f}{C_1+C_f}\left(G_{m2}+G_{o1}\right)} + \boxed{G_{o2}} + \boxed{\frac{C_2}{C_1+C_f}\cdot G_{o1}}}{\boxed{C_2} + \boxed{\frac{C_1 C_f}{C_1+C_f}}}$$

$$= -\frac{G_{o2}}{C_2} \times \underbrace{\frac{1 + \frac{C_f}{C_1+C_f}\left(\frac{G_{m2}}{G_{o2}} + \frac{G_{o1}}{G_{o2}}\right) + \frac{C_2}{C_1+C_f}\cdot\frac{G_{o1}}{G_{o2}}}{1 + \frac{1}{C_2}\cdot\frac{C_1 C_f}{C_1+C_f}}}_{>1}$$

$=$

$$\frac{1}{(1+s/p_1)} \qquad \text{pole,} \quad s+p_1=0 \Rightarrow s=-p_1$$

$$s^2+(p_1+p_2)s+p_1p_2=0$$

$$s=\underbrace{-p_1,\ -p_2}$$

$$s_1=-\frac{(\qquad)}{(\qquad)}=-p_1$$

$$s_2=-\frac{(\qquad)}{(\qquad)}=-p_2$$

$$+p_1=+\frac{(C_fG_{m2}+C_f(G_{o1}+G_{o2})+C_1G_{o2}+C_2G_{o1})}{C_1C_f+C_2C_f+C_1C_2}$$

$$+p_2=+\frac{G_{o1}G_{o2}}{(C_fG_{m2}+C_f(G_{o1}+G_{o2})+C_1G_{o2}+C_2G_{o1})}$$

"Miller Compensation"