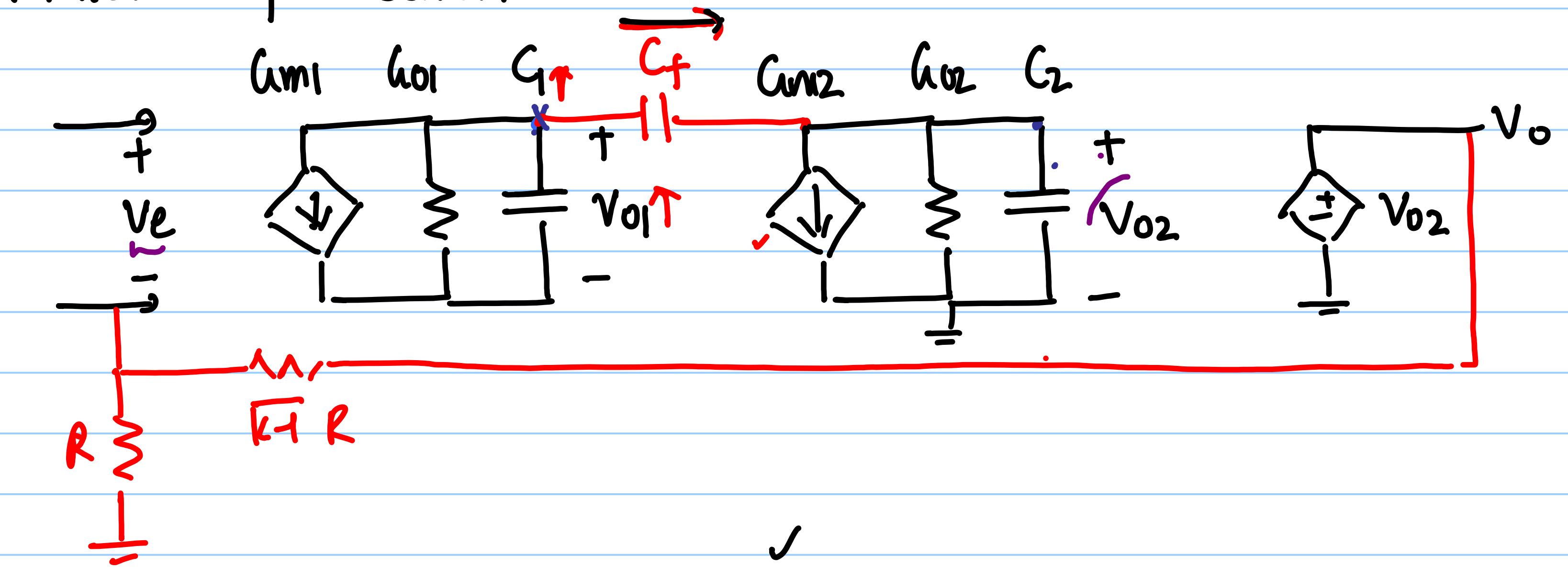
Note Title 01-03-2022

Lecture #20

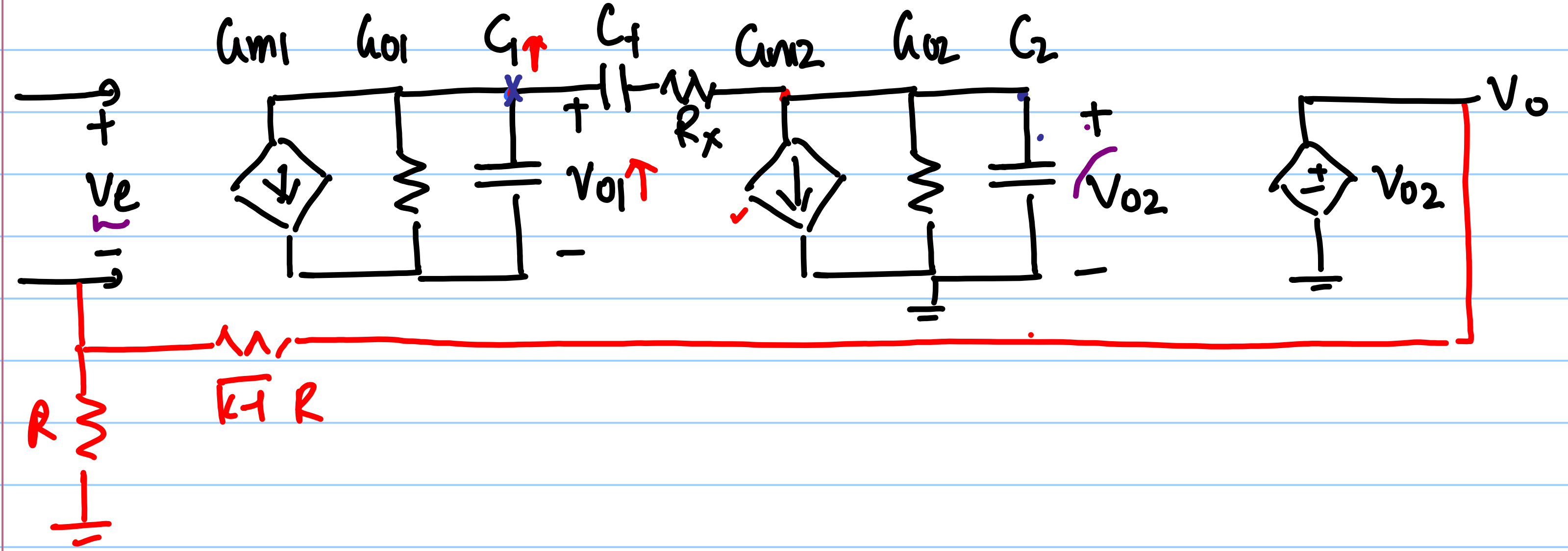
Miller Compensation



$$\frac{V_o}{V_e} = \frac{G_{m1} G_{m2} \left(1 - s C_f / G_{m2}\right)}{s^2 \left(C_1 C_f + C_2 C_f + C_1 C_2\right) + s\left(C_f G_{m2} + C_f (G_{o1} + G_{o2})\right) + s C_1 G_{o2} + s C_2 G_{o1} + G_{o1} G_{o2}}$$

$$Z_1 = \frac{G_{m2}}{C_f} \qquad (\underbrace{R.H.P\ Zero})$$

$$\measuredangle LG = -\tan^{-1}\left(\frac{\omega}{p_1'}\right) - \tan^{-1}\left(\frac{\omega}{p_2'}\right) - \underbrace{\tan^{-1}\left(\frac{\omega}{G_{m2}/C_f}\right)} \xrightarrow{\phi_m'} \phi_m \downarrow$$



$$\frac{1}{sC_f} \longrightarrow \frac{1}{sC_f} + R_x = \frac{1 + sC_f R_x}{sC_f}$$

$$N(s) = 1 - \frac{sC_f}{G_m} \longrightarrow 1 - \frac{1}{G_m}\left(\frac{1}{\frac{1}{sC_f} + R_x}\right) = 1 - \frac{1}{G_m}\frac{sC_f}{(1+sC_f R_x)}$$

$$= \frac{G_m + sC_f R_x G_m - sC_f}{G_m(1+sC_f R_x)}$$

$$= \frac{G_m + sC_f(R_x G_m - 1)}{G_m(1+sC_f R_x)}$$

$$Z_1': \frac{-G_m}{(R_x G_m - 1)C_f} < 0$$

$$\frac{1}{\left(R_x - \frac{1}{G_m}\right)} > 0$$

$R_x - 1/G_m > 0$

$$G(s) = \frac{1}{K} \frac{\frac{G_{m2}}{G_{o2}} \frac{G_{m1}}{G_{o1}} \left(1 + sC_f \left(R_x - \frac{1}{G_{m2}}\right)\right)}{s^3 \frac{C_1}{G_{o1}} \frac{C_2}{G_{o2}} C_{\cancel{x}} R_x + s^2 \left\{ C_f \left(\frac{G_{o2}}{C_2} R_x + \frac{G_{o1}}{C_1} R_x + \frac{C_1 + C_2}{G_{o1} G_{o2}} \right) + \frac{C_1 C_2}{G_{o1} G_{o2}} \right\} + s \left(C_f \left(R_x + \frac{1}{G_{o1}} + \frac{1}{G_{o2}} + \frac{G_{m2}}{G_{o2}} \frac{1}{G_{o1}} \right) + \frac{C_1}{G_{o1}} + \frac{C_2}{G_{o2}} \right) + 1}$$

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

$$Y(s) = X(s) H(s)$$

$$= \frac{1}{s} \cdot \frac{1 - s/z_1}{1 + s/p_1} = \frac{1}{s} \cdot \frac{p_1}{z_1} \frac{z_1 - s}{p_1 + s}$$

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

$$= \left[\frac{z_1}{s} - \frac{z_1+p_1}{s+p_1} \right] \times \frac{1}{z_1}$$

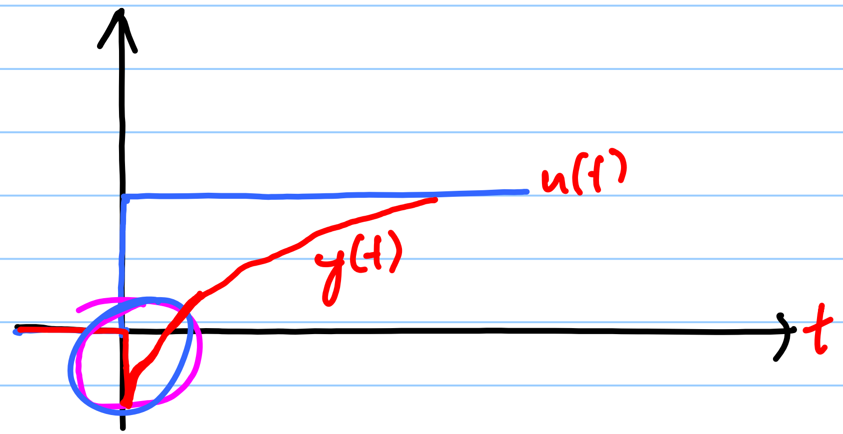
$$z_1 (\cancel{s} + p_1) - s(\cancel{z_1} + p_1)$$

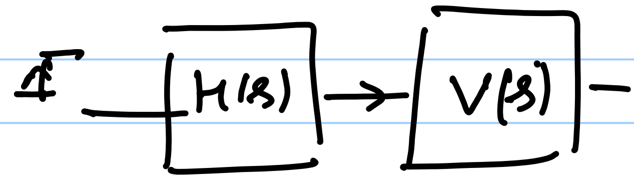
$$z_1 p_1 - s p_1$$

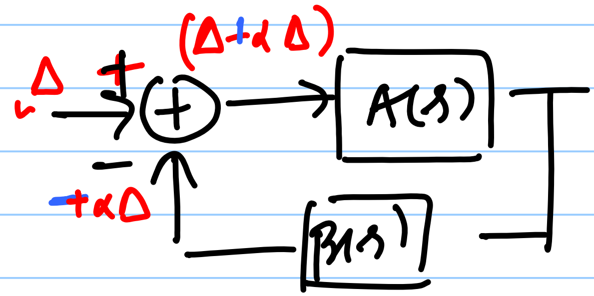
$$p_1 (z_1 - p_1)$$

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

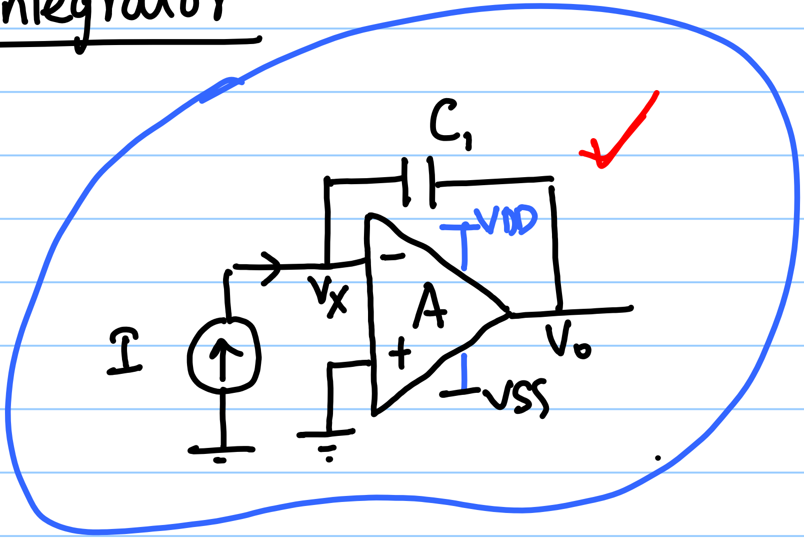
$$= \left[1 - \left(1 + \frac{p_1}{z_1}\right) e^{-p_1 t} \right] u(t)$$

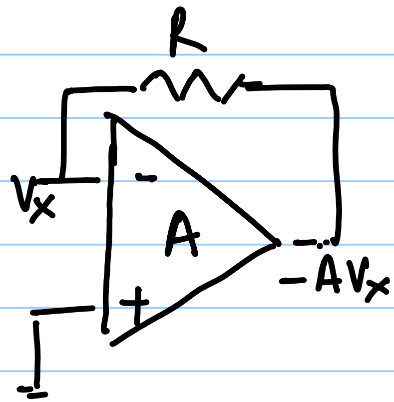






Integrator

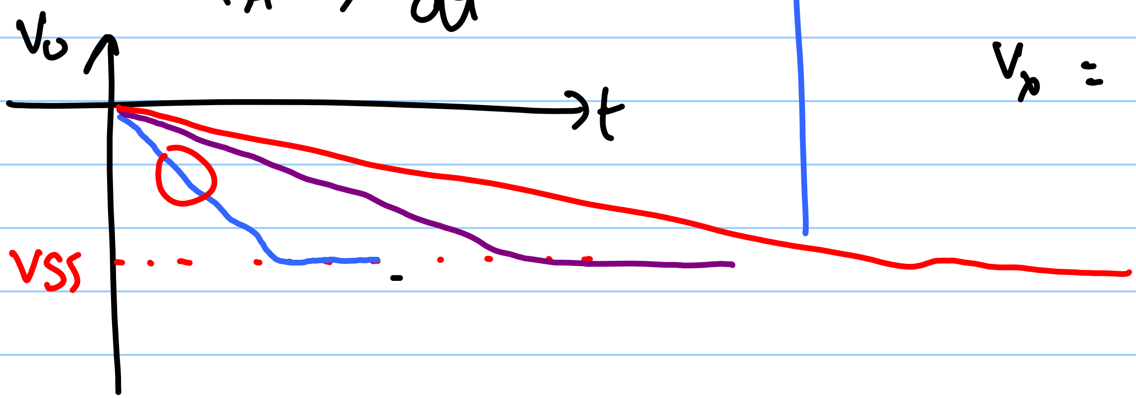




$$I = C_1 \frac{d(V_x - V_0)}{dt}$$

$$= C_1 \frac{d}{dt}\left(\frac{-V_0}{A} - V_0\right)$$

$$I = -C_1\left(\frac{1}{A}+1\right)\frac{dV_0}{dt}$$

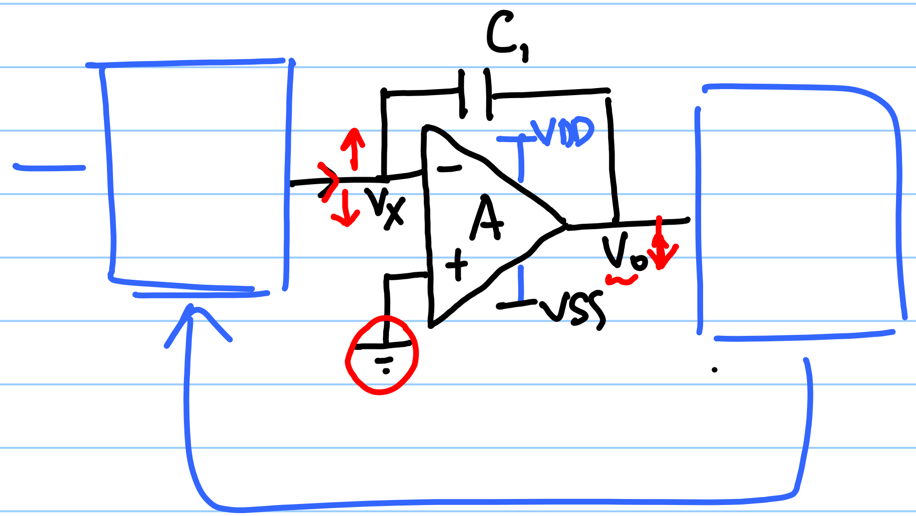


$$I = C_1 \frac{d}{dt}\left(V_x - VSS\right)$$

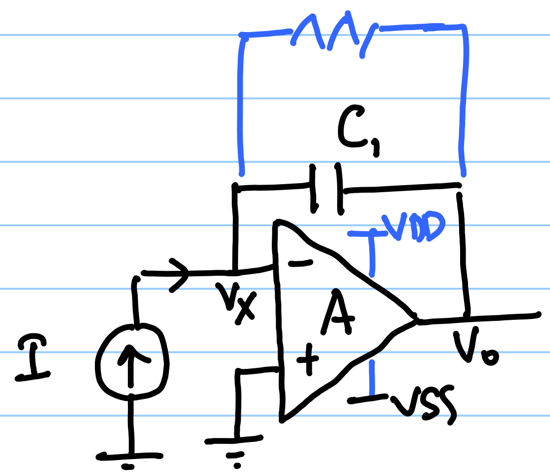
$$I = C_1 \frac{dV_0}{dt}$$

$$\frac{dV_0}{dt} = \frac{I}{C_1}$$

$$V_0 = \frac{I}{C_1} t$$



C_1
V_{DD}
V_x
A
V_o
V_{SS}



C_1
V_{DD}
V_x
A
V_o
I
V_{SS}