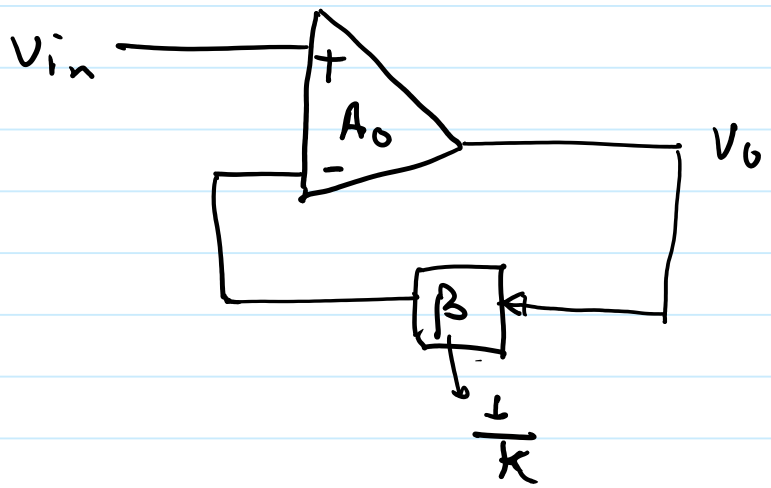
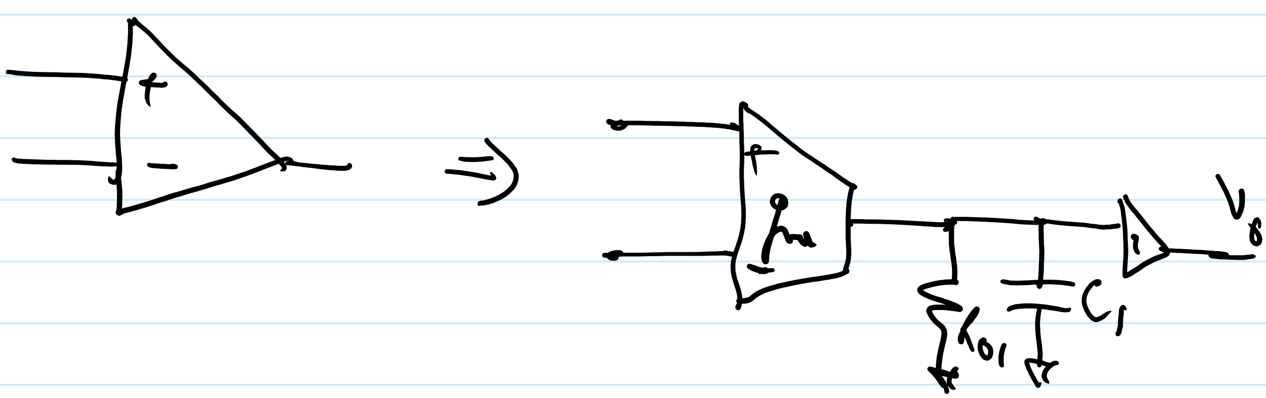
EE 2019

Tuesday, February 12, 2019 11:03 AM

1st order negative Feedback system

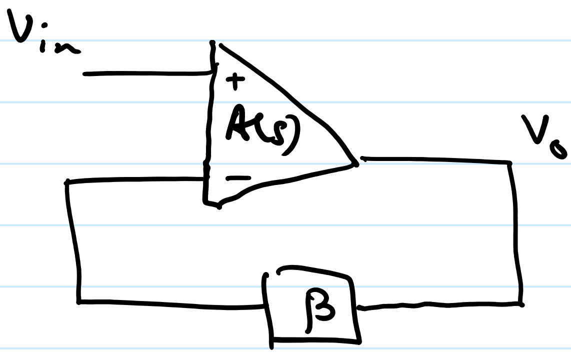


$$\frac{V_0}{V_{in}} = \frac{A_0}{1 + \beta A_0}$$



$$A_0 = g_m \cdot R_{01}$$

$$\omega_p = -\frac{1}{R_{01} C_1}$$



$$H(s) = \frac{A(s)}{1+\beta A(s)}$$

$$A(s) = \frac{A_0}{1+ s/\omega_p} \qquad ! \; A_0 = g_m R_0,$$

$$H(s) = \frac{\dfrac{A_0}{1+s/\omega_p}}{1 + \beta \dfrac{A_0}{1+s/\omega_p}}$$

$$= \frac{A_0}{(1+s/\omega_p) + \beta A_0}$$

$$= \frac{A_0}{1+\beta A_0 + s/\omega_p} = \frac{\dfrac{A_0}{1+\beta A_0}}{1 + \dfrac{s}{(1+\beta A_0)\omega_p}}$$

Pole in the closed loop system.

$$1 + A_0\beta \approx A_0\beta$$

Pole is shifted to higher frequency.

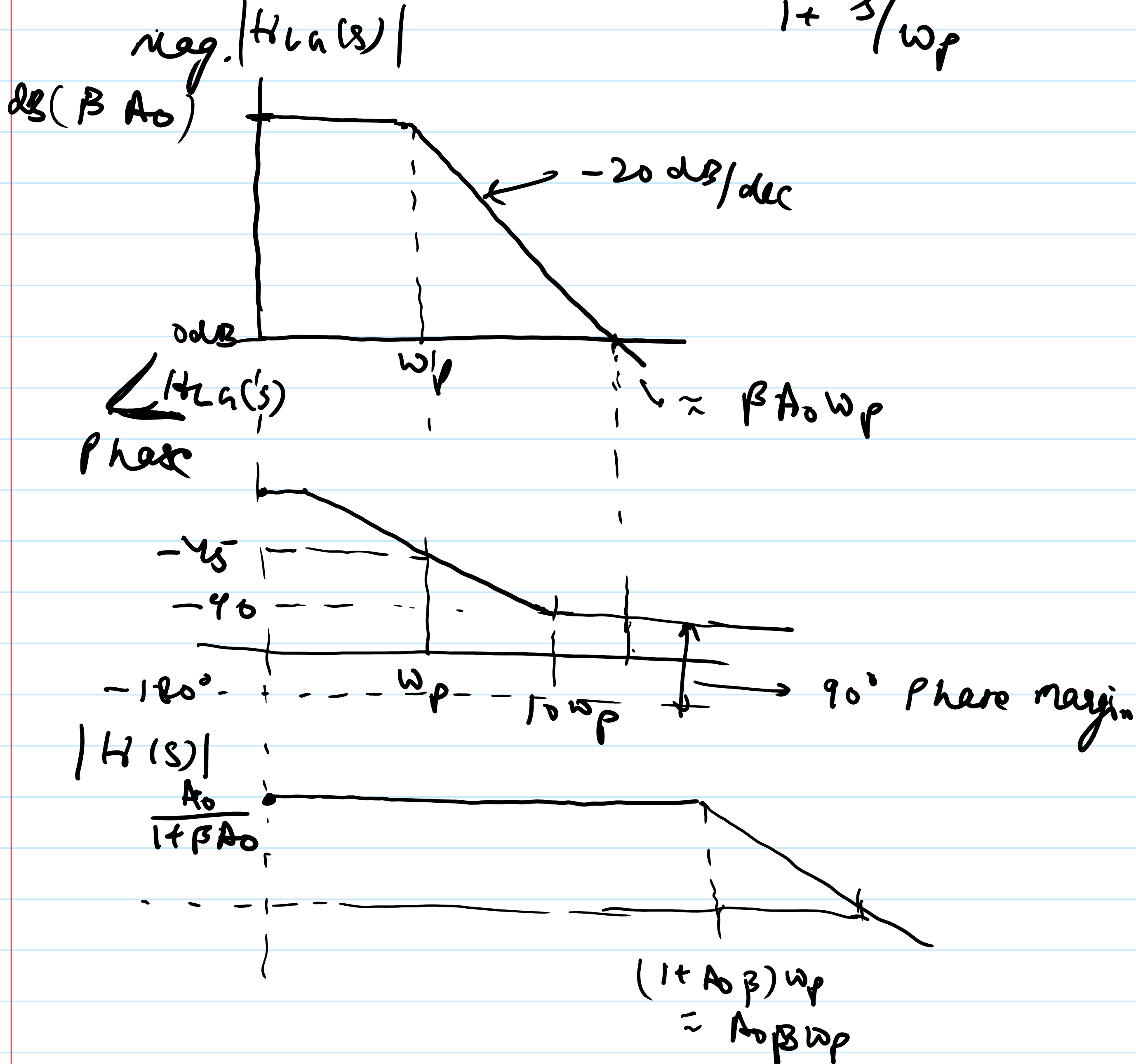
$$\omega_p' \approx A_0\beta\,\omega_p$$

$A_0\beta$ = dc loop Gain

$$H(s) = \frac{A(s)}{1 + \beta A(s)}$$

Loop Gain T.F.

$$H_{LG}(s) = \beta A(s) = \beta \frac{A_0}{1 + s/\omega_p}$$



Loop Gain Analysis simplifies the study of system stability.

$$H(s) = \frac{\frac{A_0}{1+A_0\beta}}{1 + s/(1+A\beta)\omega_p} \qquad A\beta >> 1$$

$$\approx \frac{1/\beta}{1+ s/A\beta\omega_p} = \frac{1/\beta}{1+ s/\omega_p'}$$

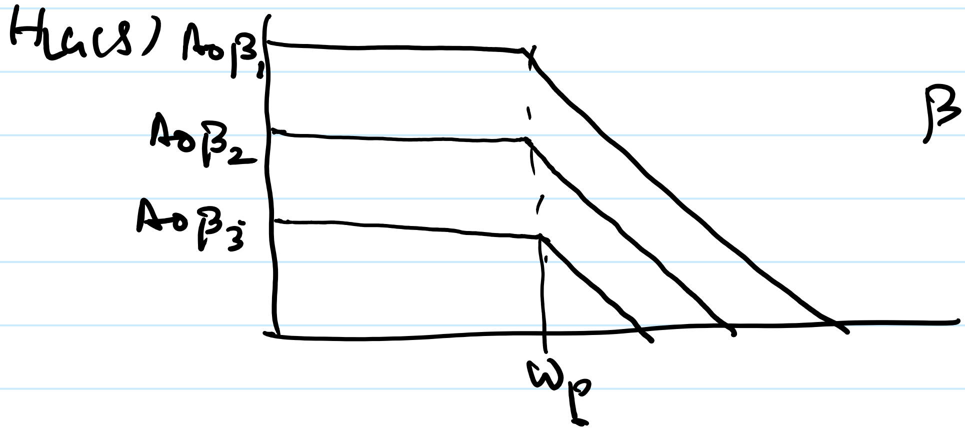
$$\omega_p' = A\beta\,\omega_p$$

3 dB frequency.

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

$$|H(s)| = \frac{1}{\sqrt{1+(\omega/\omega_p)^2}} \qquad \omega = \omega_p$$

$$= \frac{1}{\sqrt{2}} \Rightarrow -3\,dB$$



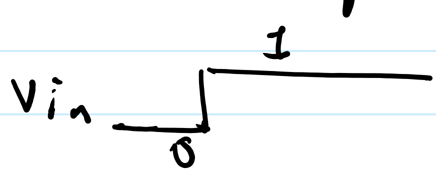
$\beta_1 > \beta_2 > \beta_3$

Step Response

Step Response is used to study the behavior of system in time domain

In order to find the step response we use Inverse L.T. to convert freq. domain T.F. into time domain.

Step response → V_{in} → step



$$V_o = H(s) \cdot V_{in}$$

$$V_o(s) = \frac{1}{s}\left(\boxed{\frac{1/\beta}{1 + s/\omega_p'}}\right)$$

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$$\mathcal{L}^{-1}\left[\frac{1/\beta}{1+s/\omega_p}\right] = \mathcal{L}^{-1}\left[\frac{\omega_p/\beta}{s+\omega_p}\right]$$

$$= \frac{\omega_p}{\beta} e^{-\omega_p t}$$