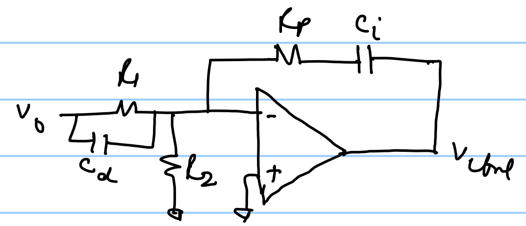
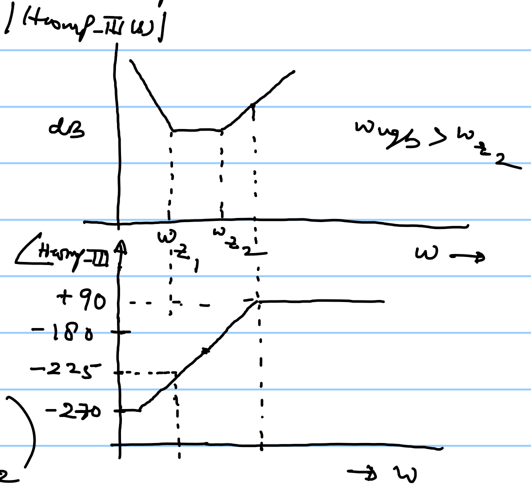
This is not preferred for applications requiring smaller ripple.

Therefore we need to add 2nd zero in the compensator.

typ-II + one zero = type-III





$$H_{comp\text{-}III}(s) = \left(K_p + \frac{K_i}{s}\right)\left(1 + s/\omega_{z_2}\right)$$

$\left(K_p + \frac{K_i}{s}\right)$ → type-II

$\left(1 + s/\omega_{z_2}\right)$ → 2nd zero

$$\omega_{z_2} = \frac{1}{R_1 C_d}$$

$$K_p + \frac{K_i}{s} = \frac{K_i}{s}\left(1 + \frac{K_p}{K_i} s\right) = \frac{K_i}{s}\left(1 + s/\omega_{z_1}\right)$$

$$\omega_{z_1} = \frac{K_i}{K_p}$$

$$H_{comp\text{-}III}(s) = k_i \frac{(1+s/\omega_{z_1})(1+s/\omega_{z_2})}{s}$$

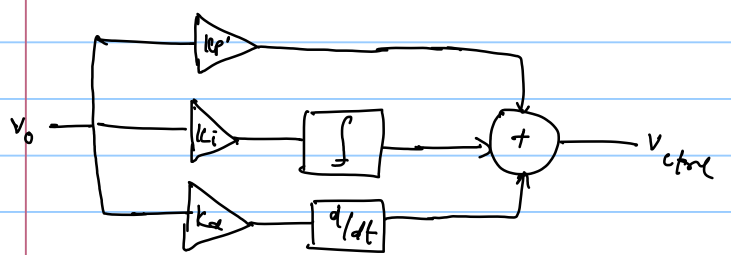
$$\frac{k_i}{s}\left[1 + s/\omega_{z_1} + s/\omega_{z_2} + \frac{s^2}{\omega_{z_1}\omega_{z_2}}\right]$$

$$= \frac{k_i}{s}\left[1 + s\left(\frac{1}{\omega_{z_1}} + \frac{1}{\omega_{z_2}}\right) + \frac{s^2}{\omega_{z_1}\omega_{z_2}}\right]$$

$$= \frac{k_i}{\omega_{z_1}}\left(1 + \frac{\omega_{z_1}}{\omega_{z_2}}\right) + \frac{k_i}{s} + k_i\frac{s}{\omega_{z_1}\omega_{z_2}}$$

$$= k_p\left(1 + \frac{\omega_{z_1}}{\omega_{z_2}}\right) + \frac{k_i}{s} + \frac{k_p}{\omega_{z_2}} s$$

P	I	D
k_p'	k_i/s	$k_d s$



Designing type-III compensator

Total gain before compensation.

$$K_{mo}\left(\frac{\omega_0}{\omega_{ugb}}\right)^2 = \angle G_{o\text{-}uncomp}.$$

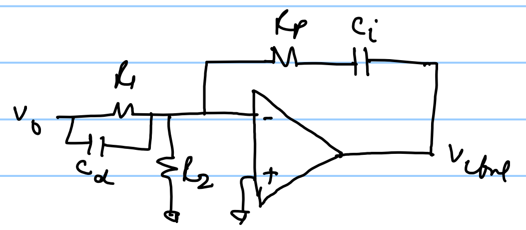
After compensation.

$$K_{mo}\left(\frac{\omega_0}{\omega_{ugb}}\right)^2 K_p\left(\frac{\omega_{ugb}}{\omega_{z_2}}\right) = 1$$

$$K_p = \frac{K_i}{\omega_{z_1}}$$

$$K_{mo}\left(\frac{\omega_0}{\omega_{ugb}}\right)^2 \frac{K_i}{\omega_{z_1}} \frac{\omega_{ugb}}{\omega_{z_2}} = 1$$

$$\boxed{K_i = \frac{\omega_{ugb}\,\omega_{z_1}\omega_{z_2}}{\omega_0^2\,K_{mo}}}$$



$L = 3.3\,\mu H, \quad C = 10\,\mu F$

$R_1 = R_2 = 100k\,\Omega, \quad V_{dd} = 1.8V, \quad V_m = 1V$

$\omega_{z_1} = \omega_0/2, \quad \omega_{z_2} = \omega_0, \quad \omega_{ugb} = 2\pi \times 100k \text{ rad/sec.}$

$$K_i = \frac{(2\pi \times 100k \text{ rad/sec}) \times \frac{\omega_0}{2} \times \omega_0}{\omega_0^2 (1.8/1)} = \frac{6.28 \times 10^5}{1.8 \times 2} = 1.74 \times 10^5 \text{ rad/sec}$$

$$K_i = \frac{1}{R_1 C_i} = 1.74 \times 10^5 \Rightarrow C_i = \frac{1}{R_1 \times 1.74 \times 10^5}$$

$R_1 = 10^5\,\Omega$

$$C_i = \frac{1}{10^5 \times 1.74 \times 10^5} = \frac{100}{1.74}\,pF = 57.4\,pF$$

$$K_p = \frac{R_p}{R_1} = \frac{K_i}{\omega_{z_1}} = \frac{1.74 \times 10^5}{1.74 \times 10^5/2} = 2$$

$\Rightarrow R_\varphi = 200K\,\Omega$

$$C_d = \frac{1}{\omega_{z_2} \times R_1} = \frac{1}{\omega_0 \times R_1} = \frac{1}{1.74 \times 10^5 \times 10^5} = 57.4\,pF$$