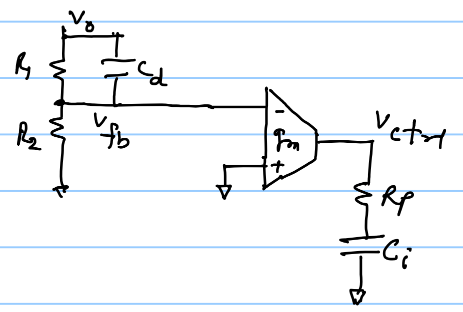
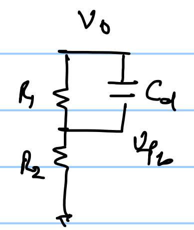
Type-III Gm-C compensator



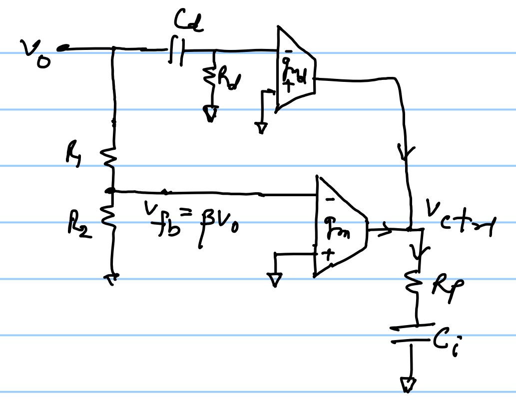


$$\frac{V_{fb}(s)}{V_o(s)} = \frac{R_2\left(\frac{1}{R_1} + sC_d\right)}{R_2\left(\frac{1}{R_1} + sC_d\right) + 1} = \frac{Z_2 Y_1}{Z_2 Y_1 + 1}$$

$$\frac{\frac{R_2}{R_1}(1 + R_1 C_d s)}{\frac{R_2}{R_1} + R_2 C_d s + 1} = \left(\frac{1 + R_1 C_d s}{1 + \frac{R_1 R_2}{R_1 + R_2} C_d s}\right)\frac{R_2}{R_1 + R_2}$$

$$= \beta\left(\frac{\overbrace{1 + R_1 C_d s}^{\text{zero}}}{\underbrace{1 + \beta R_1 C_d s}_{\text{pole}}}\right)$$

$\Rightarrow$ effect of zero is cancelled out due to pole.



$$-\left(\frac{R_d C_d s}{1 + R_d C_d s}\right) V_o \times g_{md} - \beta V_o g_m - \frac{V_{ctrl}}{R_p + \frac{1}{C_i s}} = 0$$

$$\frac{C_i s}{1 + R_p C_i s} V_{ctrl} = - V_o \left(\frac{R_d C_d s}{1 + R_d C_d s} g_{md} + \beta g_m \right)$$

$$\frac{1}{R_d C_d} >> \omega_{ugb}$$

$$\frac{V_{ctrl}(s)}{V_o(s)} = \frac{1}{C_i s} (1 + R_p C_i s) (R_d C_d s \, g_{md} + \beta g_m)$$

$$= \frac{\beta g_m}{C_i s}\left(1 + R_p C_i s\right)\left(1 + \frac{R_d C_d}{\beta}\frac{g_{md}}{g_m} s\right) = H_{comp\text{-}III}(s)$$

$$k_i = \frac{\beta g_m}{C_i}$$

$$\omega_{z_1} = \frac{1}{R_p C_i} \quad \& \quad \omega_{z_2} = \frac{\beta}{R_d C_d}\left(\frac{g_m}{g_{md}}\right)$$

$$\beta = \frac{1}{2}, \quad \frac{1}{R_d C_d} = 5\,\omega_{ugb}$$

$$\omega_{z_2} = \frac{5}{2}\omega_{ugb}\left(\frac{g_m}{g_{md}}\right)$$

$$\omega_{z_2} = \omega_0$$

$$\omega_0 = 2.5\,\omega_{ugb}\left(\frac{g_m}{g_{md}}\right)$$

$$\Rightarrow g_{md} = 2.5\left(\frac{\omega_{ugb}}{\omega_0}\right)(g_m)$$