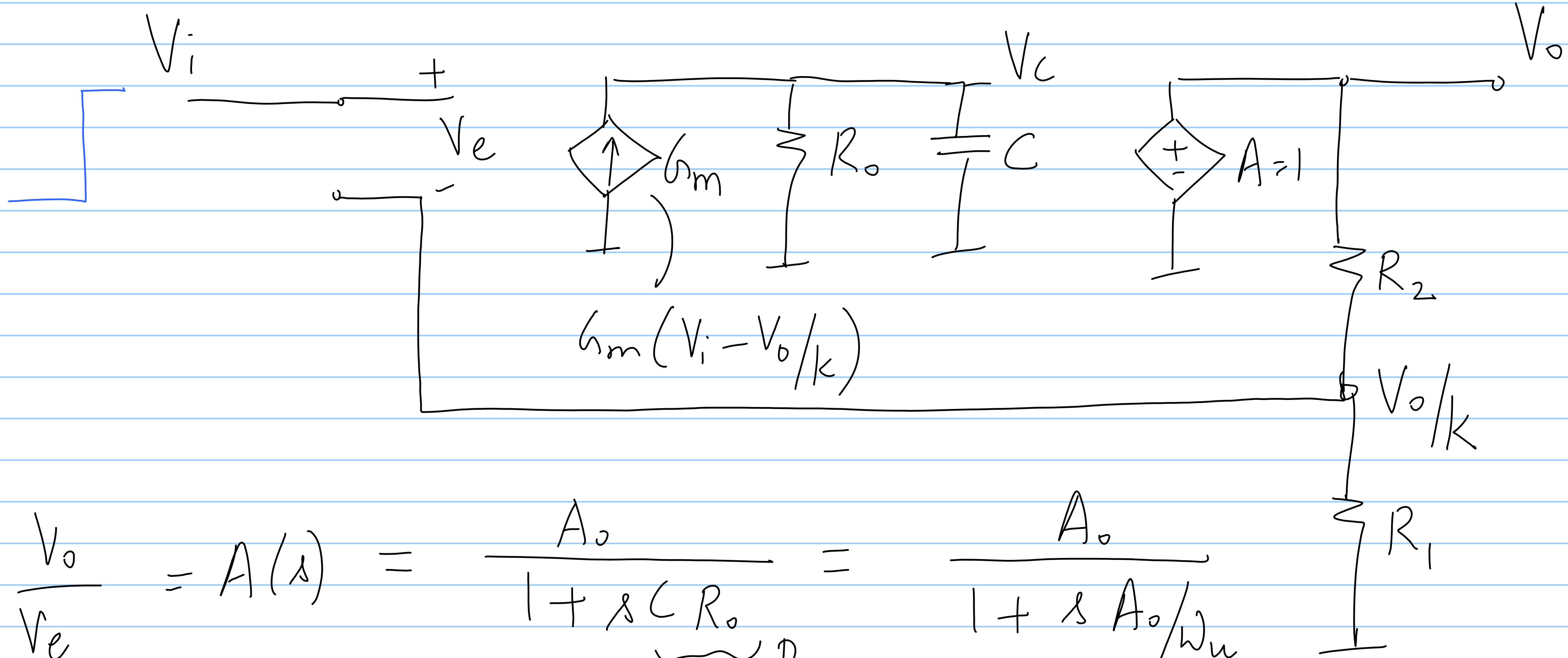
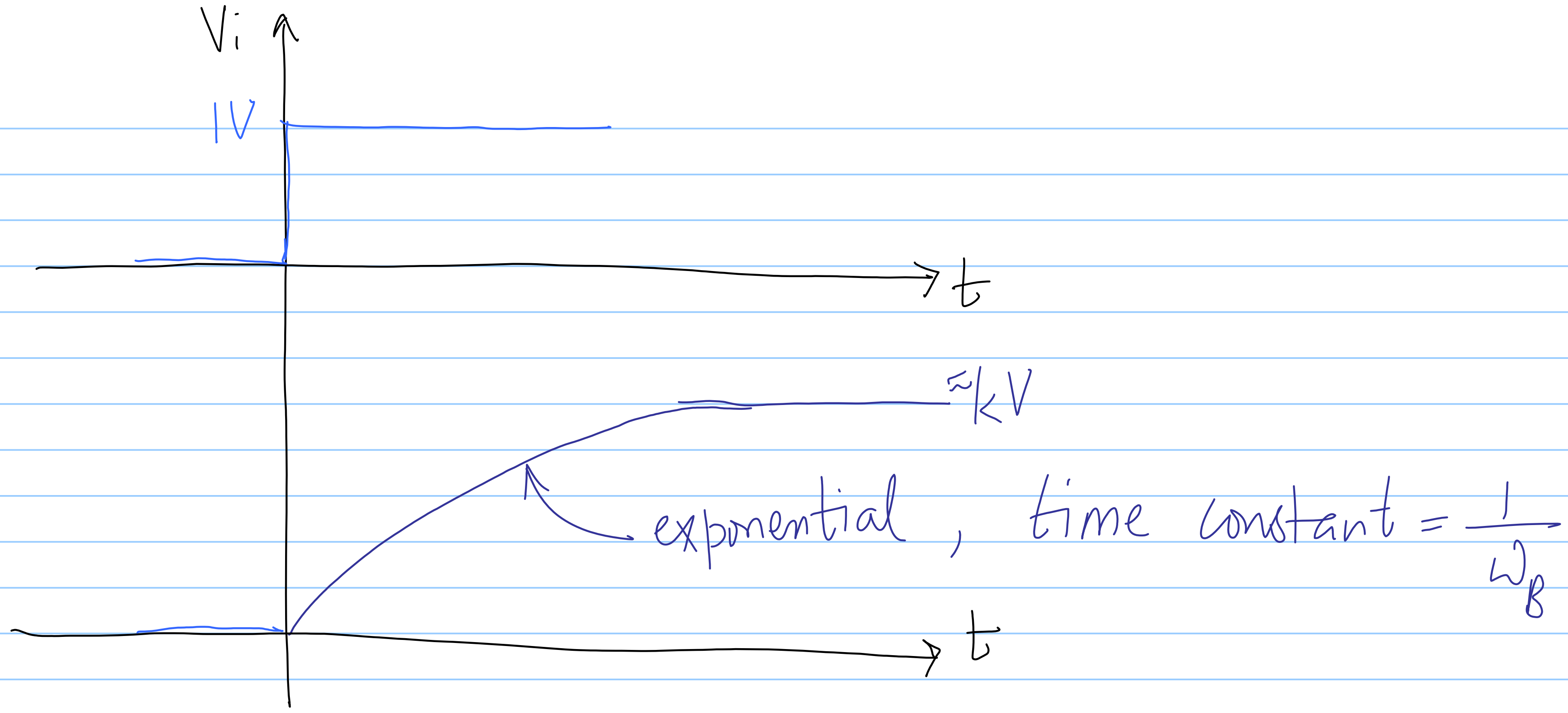
13/2/19

Lec 15



$$\frac{V_o}{V_e} = A(s) = \frac{A_o}{1 + s\underbrace{CR_o}_{p_1}} = \frac{A_o}{1 + s\,A_o/\omega_u}$$

$$A_o = G_m R_o \quad ; \quad \omega_u = \frac{G_m}{C}$$



$$\frac{V_o}{V_i}(s) = ?$$

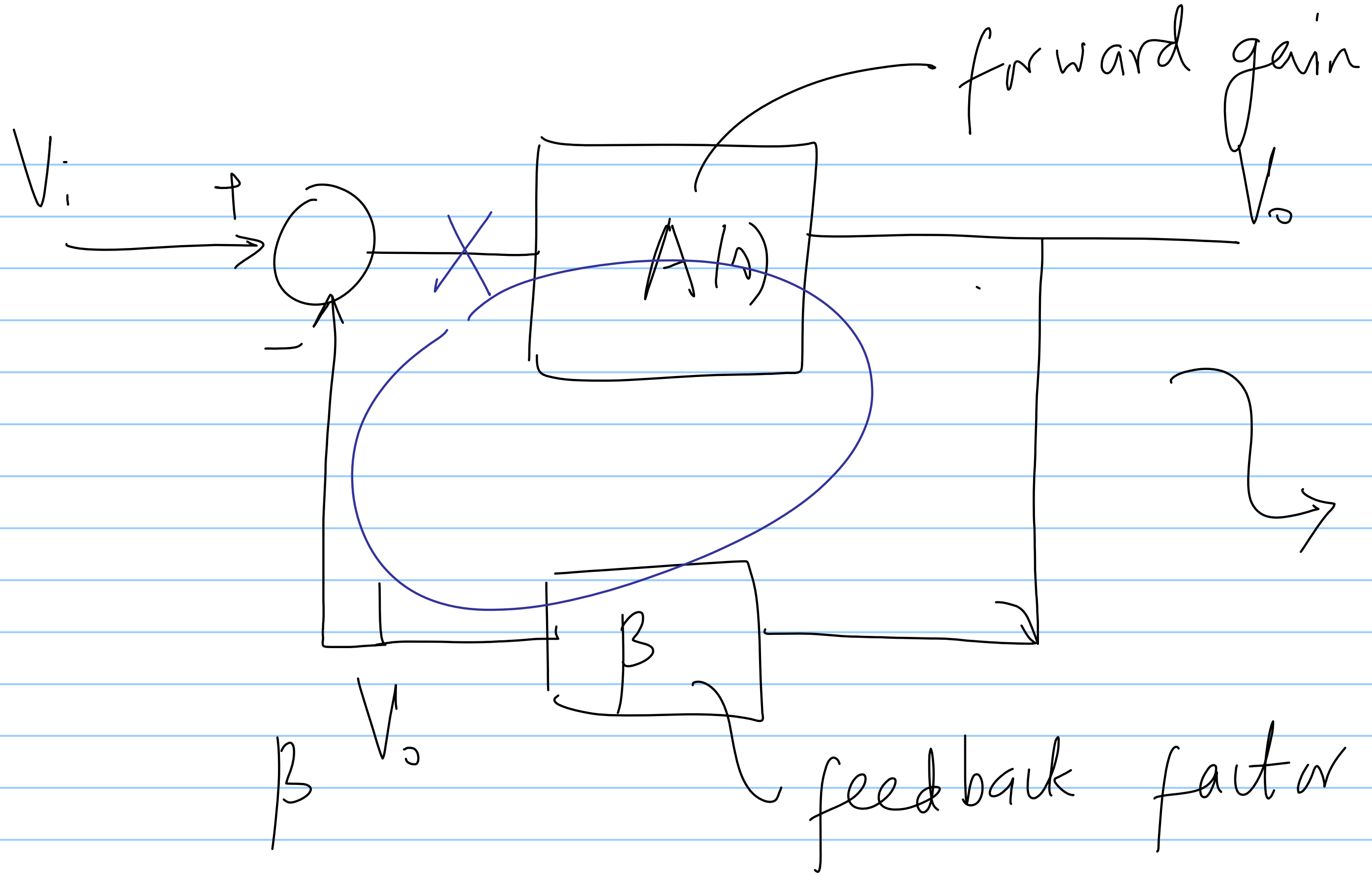
$$V_e(s) = V_i(s) - \frac{V_o(s)}{k}$$

$$V_o(s) = A(s) \cdot V_e(s)$$

$$= V_i(s) \cdot A(s) - V_o(s) \cdot \frac{A(s)}{k}$$

$$V_o(s) \left\{ 1 + \frac{A(s)}{k} \right\} = V_i(s) \cdot A(s)$$

$$\frac{V_o(s)}{V_i(s)} = \frac{A(s)}{1 + \frac{A(s)}{k}}$$



$$\frac{V_o}{V_i} = \underbrace{\frac{A(n)}{1+\beta A(n)}}_{\text{"closed loop gain"}}$$

$\beta A(n)$ = "Loop gain"

$$\frac{V_o}{V_i}(s) = \frac{A(s)}{1 + \frac{A(s)}{k}} = \frac{A_o/(1+sCR_o)}{1 + \frac{A_o/(1+sCR_o)}{k}}$$

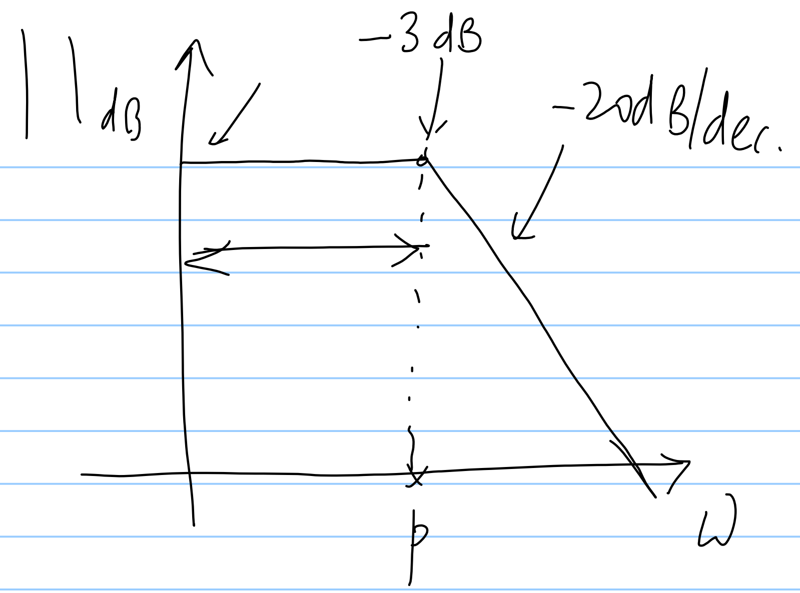
$$= \frac{kA_o}{k(1+sCR_o) + A_o} = \frac{kA_o}{k + A_o + sCR_o}$$

$$= k \cdot \underbrace{\left(\frac{1}{1 + \frac{k}{A_o}}\right)}_{} \cdot \frac{1}{1 + \frac{s}{\omega_B}}$$

$$\omega_B = \frac{A_o + k}{CR_o k}$$

$$\omega_B = p_1\left(1+\frac{A_0}{K}\right)$$

1 pole @ → $p_1\left(1+\frac{A_0}{K}\right)$
(LHP)



"−3 dB Bandwidth"

1-pole system.

$$\left|\frac{A}{(1+s/p)^2}\right| = \frac{A}{\sqrt{2}}$$

$$\frac{A}{1+s/p}$$

$$|\;| @ p = \frac{A}{\sqrt{2}}$$

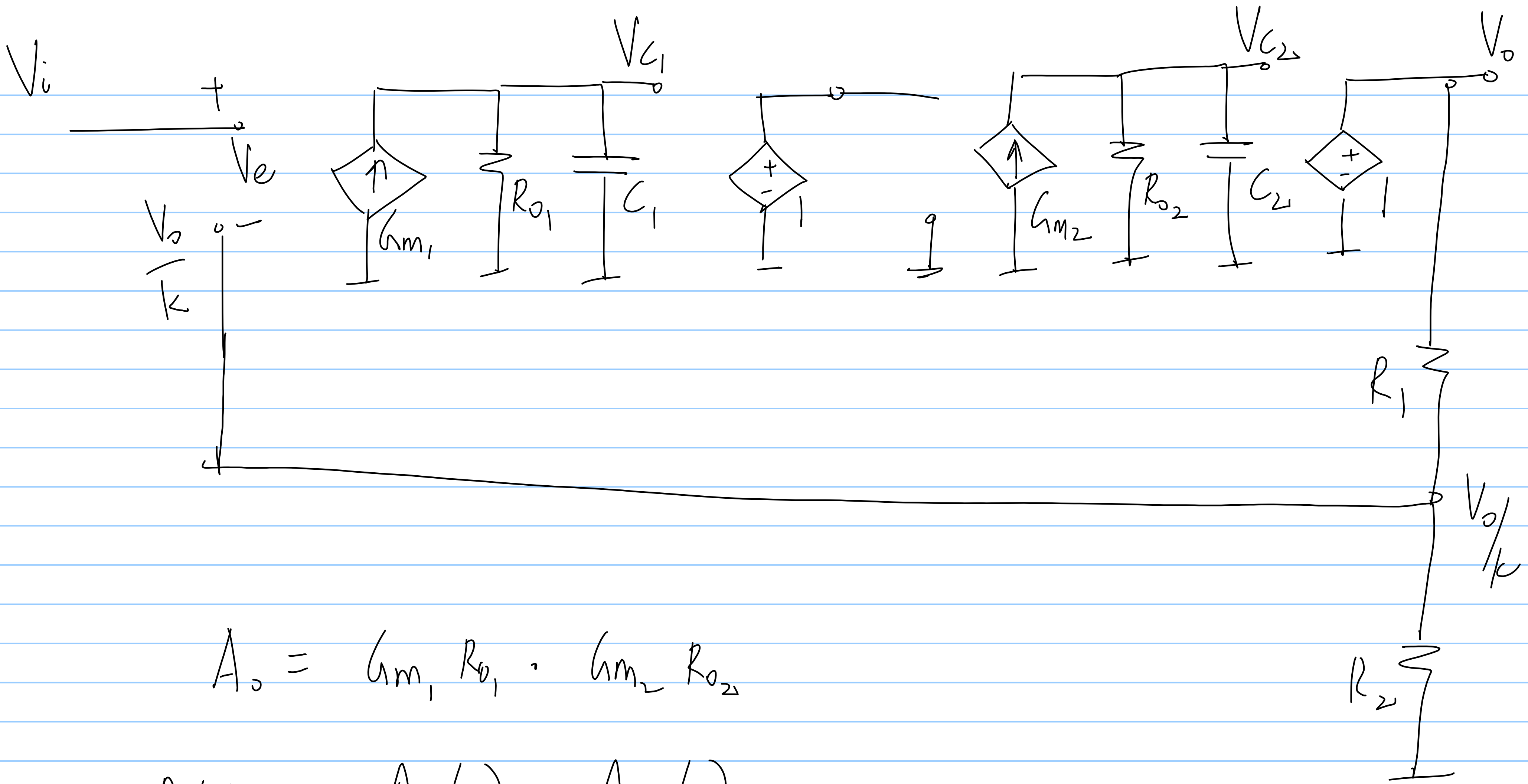
fast response → large $\frac{A_o}{k}$; large ω_u

large G_m

small C

$G_m R_o$ — finite

few 10^s to 100-200



$$A_o = G_{m_1} R_{o_1} \cdot G_{m_2} R_{o_2}$$

$$A(s) = A_1(s) \cdot A_2(s)$$

$$A_1(s) = \frac{A_{01}}{1 + \underbrace{sC_1 \cdot R_{01}}_{1/p_1}} \quad ; \quad A_2(s) = \frac{A_{02}}{1 + \underbrace{sC_2 R_{02}}_{1/p_2}}$$

$$\frac{V_o(s)}{V_e(s)} = A(s)$$

$$\frac{V_o(s)}{V_i(s)} = \frac{A(s)}{1 + \frac{A(s)}{k}}$$

$$p_1 = \frac{1}{C_1 R_{01}} \quad ; \quad p_2 = \frac{1}{C_2 R_{02}}$$