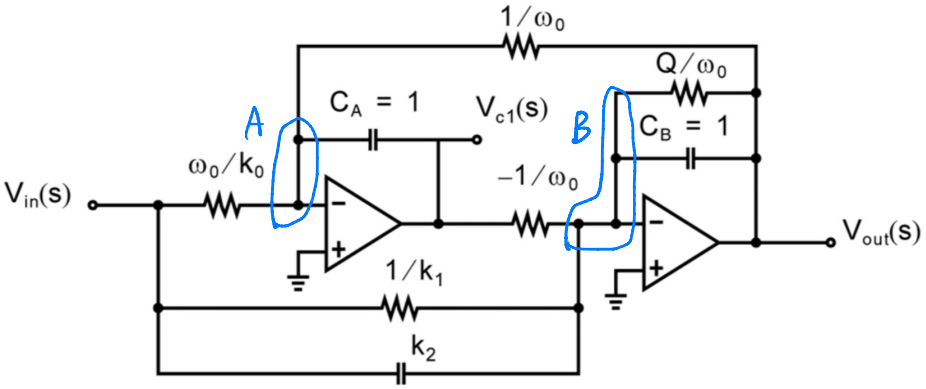
Make-up Project
ECE 580
Due November 22, 2023



Solution: 1. KCL @ node A: $\frac{V_{in}(s)}{\omega_0/k_0} + V_{c1}(s)\cdot sC_A + \frac{V_{out}(s)}{1/\omega_0} = 0$ ①

KCL @ node B: $\frac{V_{c1}(s)}{-1/\omega_0} + V_{in}(s)\left(\frac{1}{1/k_1} + sk_2\right) + V_{out}(s)\left(\frac{1}{Q/\omega_0} + sC_B\right) = 0$ ②

$C_A = C_B = 1$

From ①, $V_{c1}(s) = -\frac{1}{s}\left[\frac{k_0}{\omega_0}V_{in}(s) + \omega_0 V_{out}(s)\right] = 0$ ③

According to ② and ③.

$\frac{\omega_0}{s}\left[\frac{k_0}{\omega_0}V_{in}(s) + \omega_0 V_{out}(s)\right] + V_{in}(k_1 + sk_2) + V_{out}\left(\frac{\omega_0}{Q} + s\right) = 0$

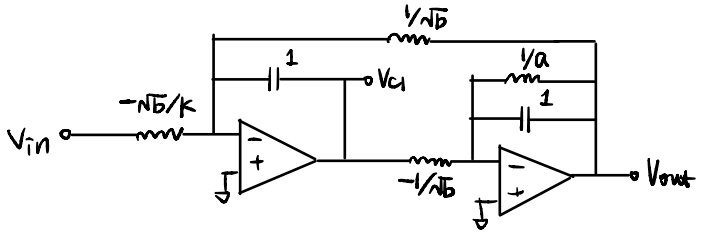
$\Rightarrow (k_0 + k_1 s + k_2 s^2)V_{in}(s) + \left(\omega_0^2 + \frac{\omega_0}{Q}s + s^2\right)V_{out}(s) = 0$

$\Rightarrow \frac{V_{out}(s)}{V_{in}(s)} = -\frac{k_2 s^2 + k_1 s + k_0}{s^2 + (\omega_0/Q)s + \omega_0^2}$

2. $H(s) = \frac{K}{s^2 + as + b} = -\frac{k_2 s^2 + k_1 s + k_0}{s^2 + (\omega_0/Q)s + \omega_0^2}$

$\Rightarrow \begin{cases} k_1 = k_2 = 0, \; k_0 = -K \\ \omega_0/Q = a, \; \omega_0^2 = b \end{cases}$

Therefore, $\begin{cases} k_1 = 0, \; k_2 = 0, \; k_0 = -K \\ \omega_0 = \sqrt{b} \quad Q = \frac{\sqrt{b}}{a} \end{cases}$



The values of resistors scale inversely proportional to the real value of C_A and C_B.

Negative sign means cross-coupling in fully-differential circuits.