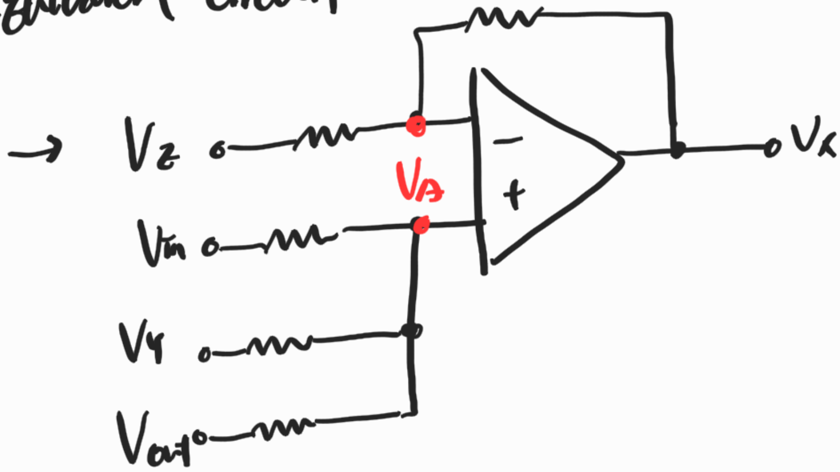
< prob 2 >

Equivalent circuit




$$\rightarrow \begin{cases} \dfrac{V_Z+V_X}{2} = V_A = \dfrac{V_{in}+V_Y+V_{out}}{3} & -① \\ V_{out} = -\dfrac{1}{RC_3 s}V_Z \rightarrow V_Z = -RC_3 s \cdot V_{out} & -② \\ V_Z = -\dfrac{1}{RC_2 s}V_Y \rightarrow V_Y = R^2 C_2 C_3 s^2 V_{out} & -③ \\ V_Y = -\dfrac{1}{RC_1 s}V_X \rightarrow V_X = -R^3 C_1 C_2 C_3 s^3 V_{out} & -④ \end{cases}$$

①, ②, ③, ④ $\rightarrow H(s) = \dfrac{-\frac{2}{3}\frac{1}{R^3 C_1 C_2 C_3}}{s^3 + \frac{2}{3}\frac{1}{RC_1}s^2 + \frac{1}{R^2 C_1 C_2}s + \frac{2}{3}\frac{1}{R^3 C_1 C_2 C_3}}$ (a)

Butterworth Response $\longrightarrow H(s) = \dfrac{k}{(s+w_n)(s^2 + \frac{w_n}{Q}s + w_n^2)}$

$P_{1,2} = 2\pi \times f_0 \times \left(\cos\frac{2}{3}\pi \pm j\sin\frac{2}{3}\pi\right)$,

$\rightarrow \dfrac{w_0}{Q} = -(P_1+P_2) = w_0 \rightarrow Q=1,\ w_n = \sqrt[3]{\dfrac{2}{3}\cdot\dfrac{1}{R^3 C_1 C_2 C_3}}$ (b)

비교.

$\Rightarrow H(s) = \dfrac{k}{s^3 + 2w_n s^2 + 2w_n^2 s + w_n^3}$

(d) $f_0 = 1MHz$ & $R = 1k\Omega$ & [illegible]

$$\rightarrow \quad 2w_n = \frac{2}{3}\frac{1}{RC_1} \rightarrow w_n = \frac{1}{3}\cdot\frac{1}{RC_1} \rightarrow C_1 = \frac{1}{3}\cdot\frac{1}{Rw_n} \fallingdotseq 53pF$$

$$2w_n^2 = \frac{1}{R^2C_1C_2} \rightarrow w_n = \frac{3}{2}\cdot\frac{1}{RC_2}$$

$$\rightarrow C_2 = \frac{3}{2}\cdot\frac{1}{Rw_n} \fallingdotseq 238pF$$

$$\rightarrow w_n^3 = \frac{2}{3}\cdot\frac{1}{R^3C_1C_2C_3} \rightarrow C_3 = \frac{2}{3}\cdot\frac{1}{R^3\cdot C_1C_2\cdot w_n^3} \fallingdotseq 213pF$$