HOMEWORK 4 SOLUTIONS

1. GmC biquad transfer function

$$H(s) \equiv \frac{V_{out}(s)}{V_{in}(s)} = \frac{s^2\left(\frac{C_X}{C_X + C_B}\right) + s\left(\frac{G_{m5}}{C_X + C_B}\right) + \left(\frac{G_{m2}G_{m4}}{C_A(C_X + C_B)}\right)}{s^2 + s\left(\frac{G_{m3}}{C_X + C_b}\right) + \left(\frac{G_{m1}G_{m2}}{C_A(C_X + C_B)}\right)}$$

We want a lowpass transfer function

$$H(s) = \frac{k_0}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2}$$

with $\omega_0 = 2\pi \cdot 10\text{MHz}$, $Q = 1$, and $k_0 / \omega_0^2 = 5$.

Take all capacitances in the circuit to be a reasonable value; for example $C = 5\text{pF}$. We must now find G_{m1-m4}:

$$G_{m1} = G_{m2} = \omega_0 C = 0.314\text{mA/V}$$

$$G_{m3} = \omega_0 C / Q = 0.314\text{mA/V}$$

$$G_{m4} = k0C / \omega_0 = 5G_{m1-m3} = 1.57\text{mA/V}$$

We have to choose Gm5 = 0 and Cx = 0.

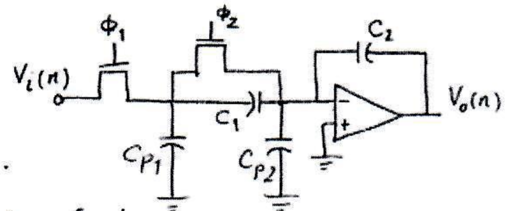
2. $C_2 V_o(n) = C_2 V_o(n-1) - C_1 V_i(n)$

$$\Rightarrow C_2 V_o(z) = C_2 z^{-1} V_o(z) - C_1 V_i(z) \Rightarrow \underline{\frac{V_o(z)}{V_i(z)} = \frac{-C_1/C_2}{1-z^{-1}}}$$

[redacted]

1.5)

C_{P2} is always discharged since its voltage is virtually ground.



During Φ_1, C_{P1} is charged to $V_i(n) C_{P1}$.

This charge will be transfered to C_2 during Φ_2. Therefore: $C_2 V_o(n) = C_2 V_o(n-1) - C_{P1} V_i(n-1) - C_1 V_i(n)$

$$\Rightarrow \underline{\frac{V_o(z)}{V_i(z)} = -\frac{\frac{C_1}{C_2} + \frac{C_{P1}}{C_2} z^{-1}}{1-z^{-1}}}$$