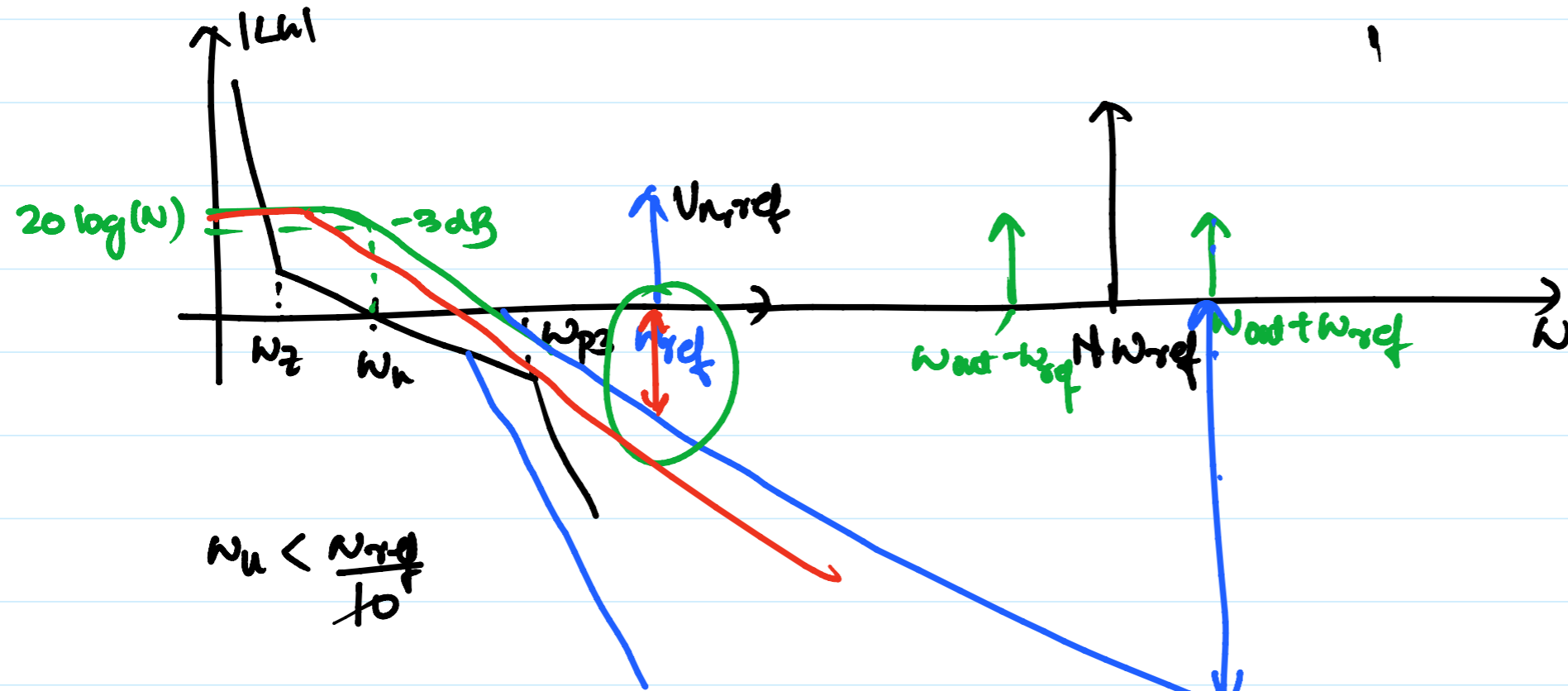


$V_{n,ref}$

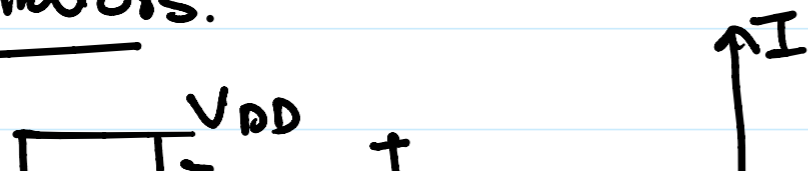
 $V_{out} = A \sin(\omega_{out} t + K_{VCO} \int v_{n,ref} \cdot dt)$

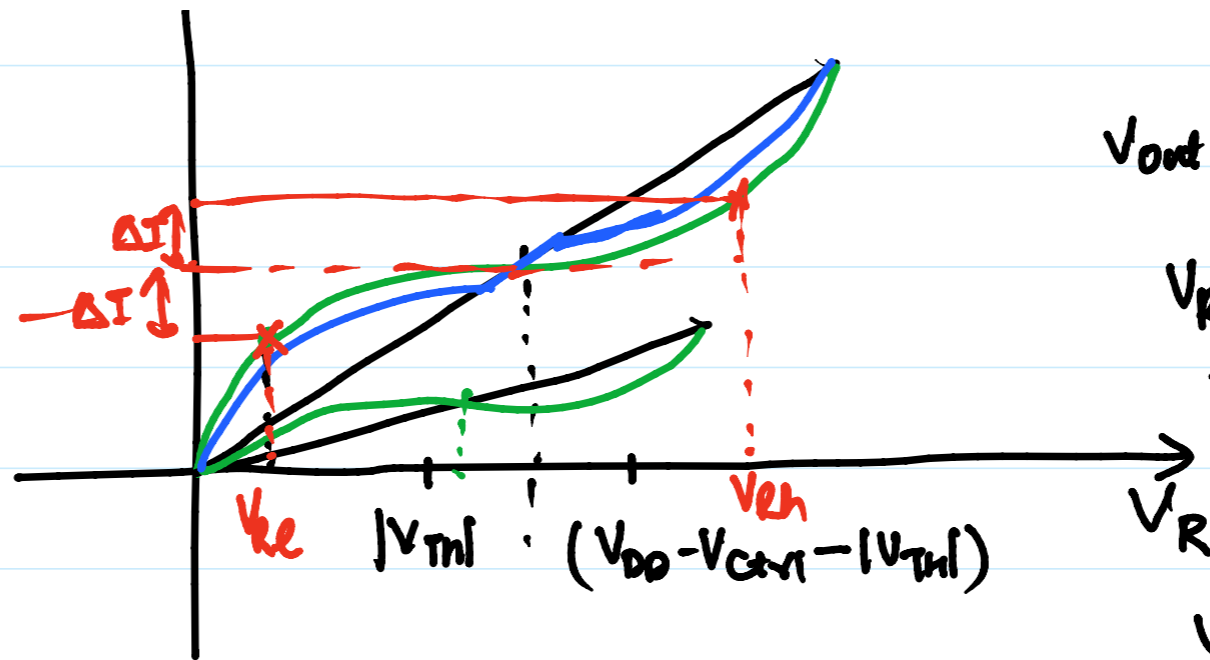
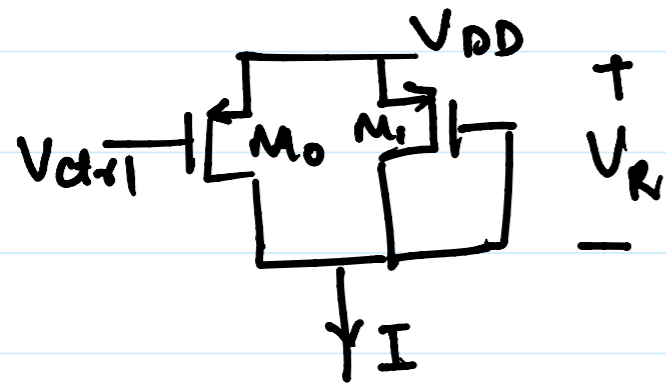
$V_{in} = A_{in} \sin(\omega_{ref} t)$

$V_{out} = A_{out} \sin(N \omega_{out} t) = A_{out} \sin(N \omega_{ref} t)$



Oscillators.





$$V_{out} = V_{DD} - V_{ctrl}$$

$$V_{RL} + V_{RH} = V_{DD} - V_{ctrl}$$

$$I = \frac{KN}{L} \left[(V_{DD} - |V_{th}| - V_{ctrl}) V_R - \frac{V_R^2}{2} \right]$$

$$\frac{V_{DD} - V_{ctrl}}{2} - \Delta V_1 + \frac{V_{DD} - V_{ctrl}}{2} + \Delta V_2 = V_{DD} - V_{ctrl}$$

$$I = \frac{KN}{L} \left[(V_{DD} - V_{ctrl} - 2|V_{th}|) V_R + \frac{|V_{th}|^2}{2} \right]$$

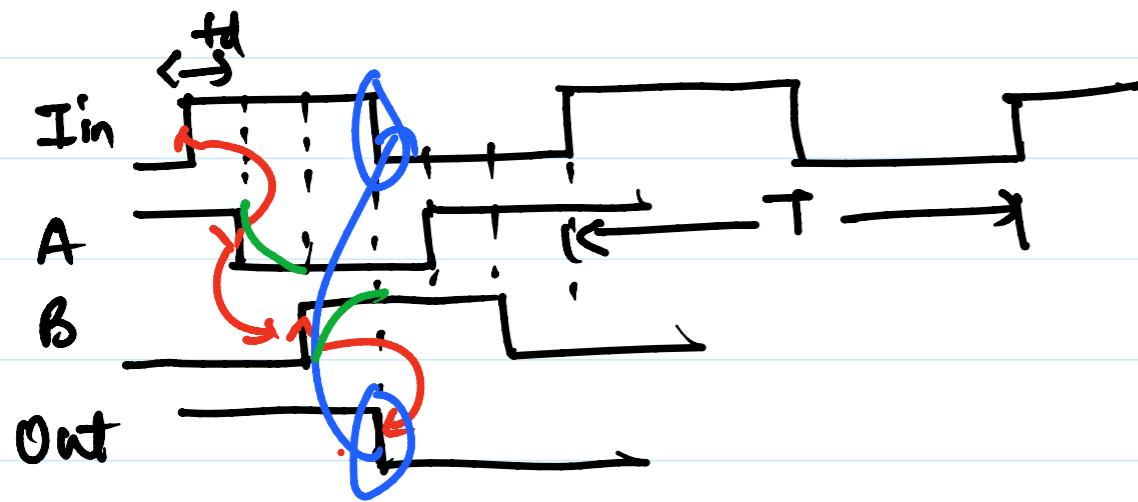
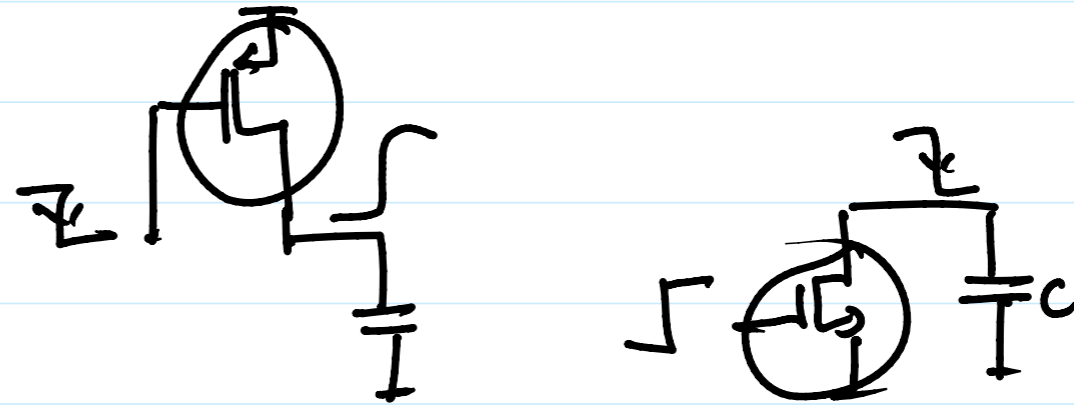
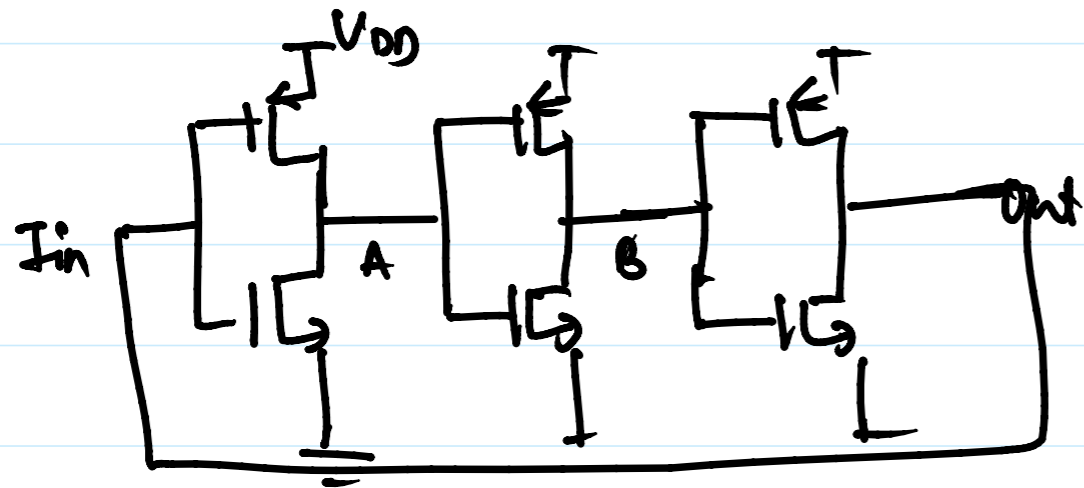
$$\Delta V_1 = \Delta V_2$$

$$I = \frac{KN}{2L} \left[(V_{DD} - V_{ctrl} - |V_{th}|)^2 \right] + \frac{KN}{2L} (V_R - |V_{th}|)^2$$

Low-swing oscillators

- limited op swing → low-swing to high swing conv.
- constant current consumption
- poor phase noise
- better PSRR

Large-swing oscillators.

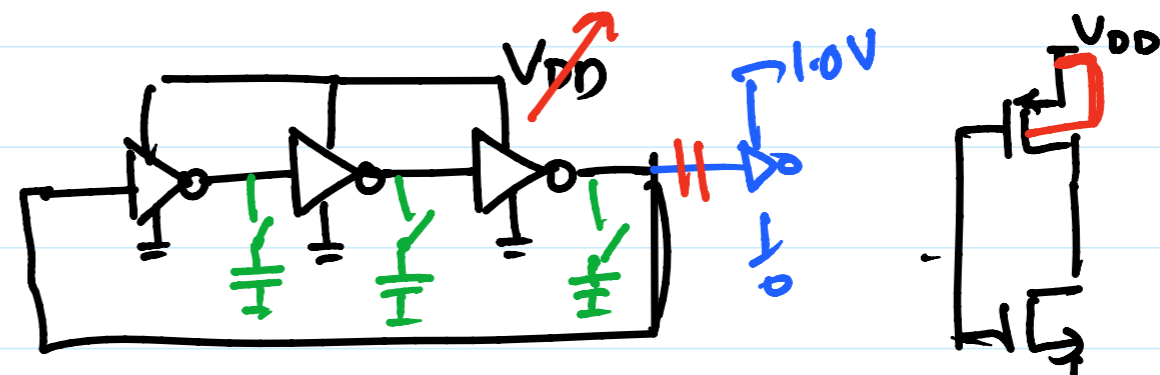
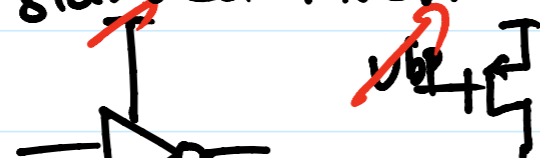


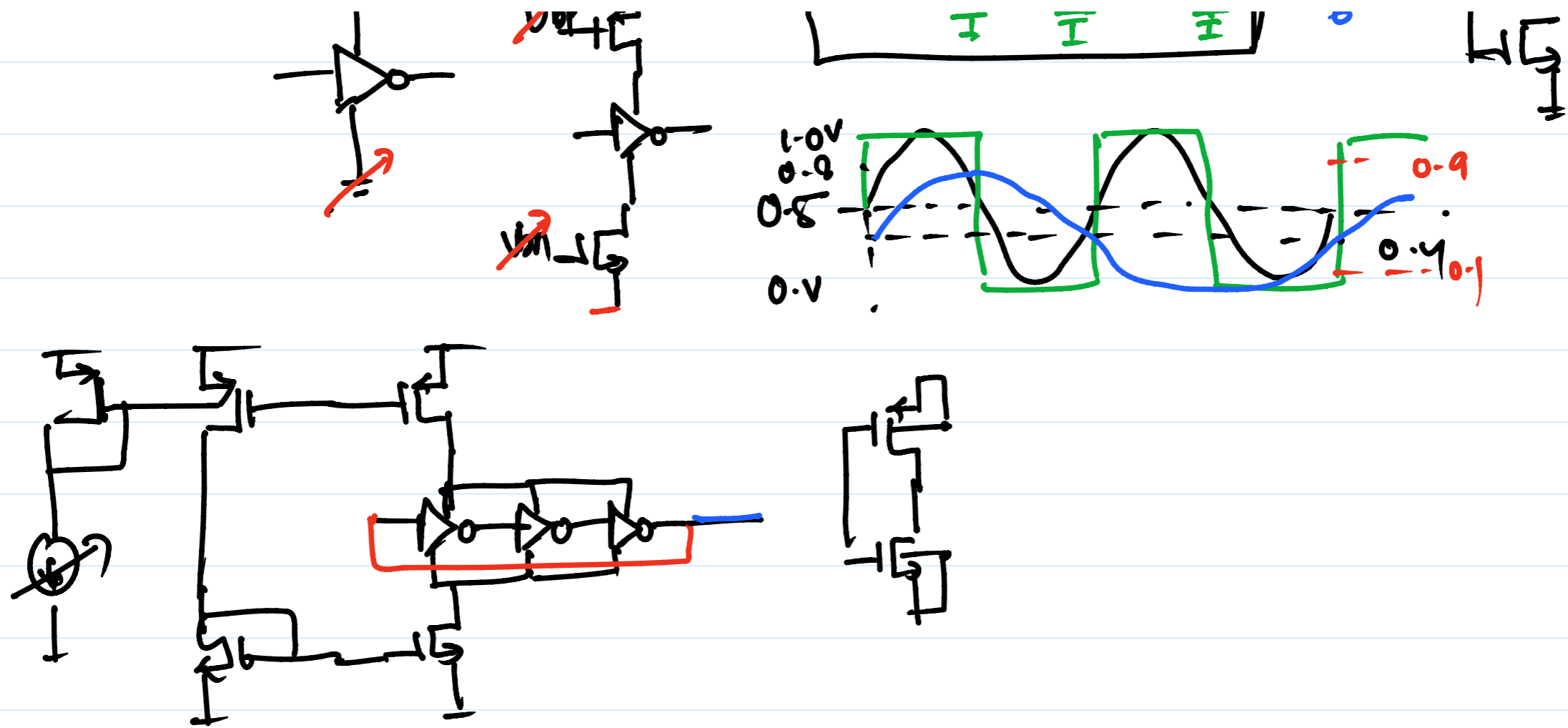
$$\frac{T}{2} = 3t_d$$

$$f_{osc} = \frac{1}{T} = \frac{1}{6t_d}$$

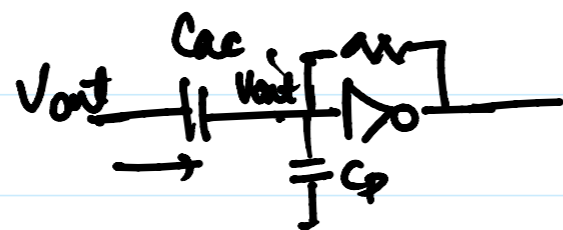
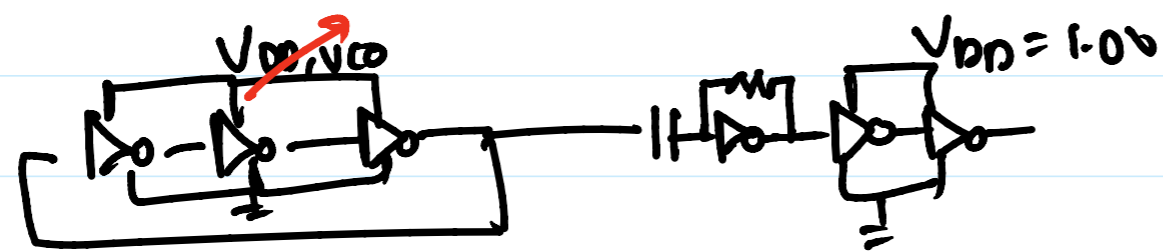
Tuning frequency of full-swing osc.

- Vary V_{dd}
- Current starved inverter

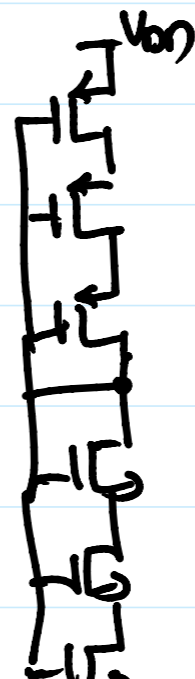
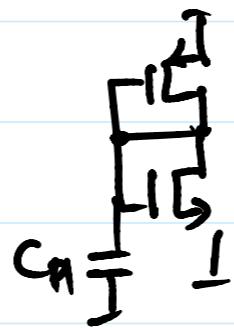




- Capacitive loading at oscillator nodes.



$$\frac{1}{\omega C_p} = \frac{1}{2\pi \times 5 \times 10^6} \approx 18 \text{ ns}$$



$$= \frac{1}{150 \times 10^{-6}} = \frac{1}{150 \times 10^{-3} \text{ (m)}}$$

5 cm

$C_{p2} > C_{p1}$

