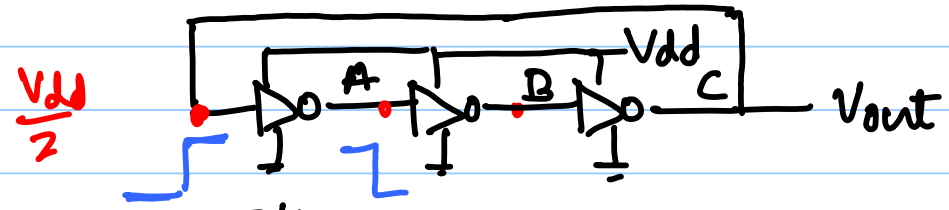
Lecture #23

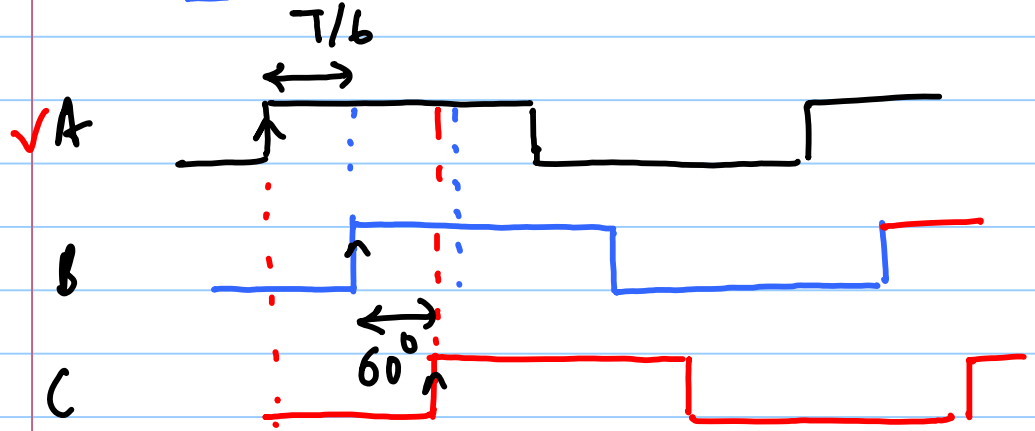
Note Title 16-07-2020

Ring Oscillator



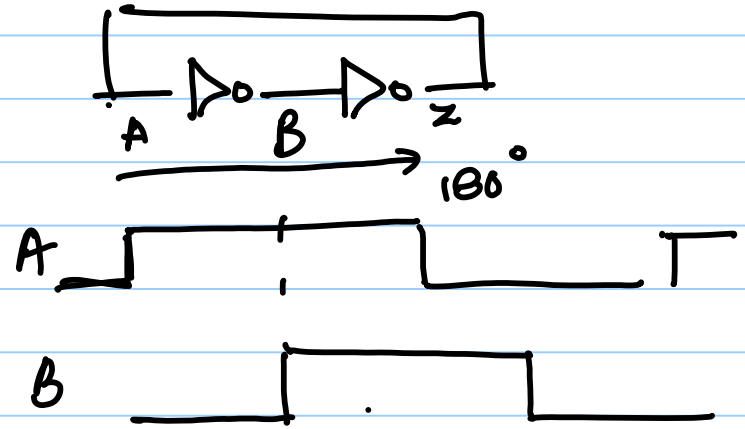
$$f_0 = \frac{1}{6t_d} = \frac{1}{3(t_{dp} + t_{dN})}$$

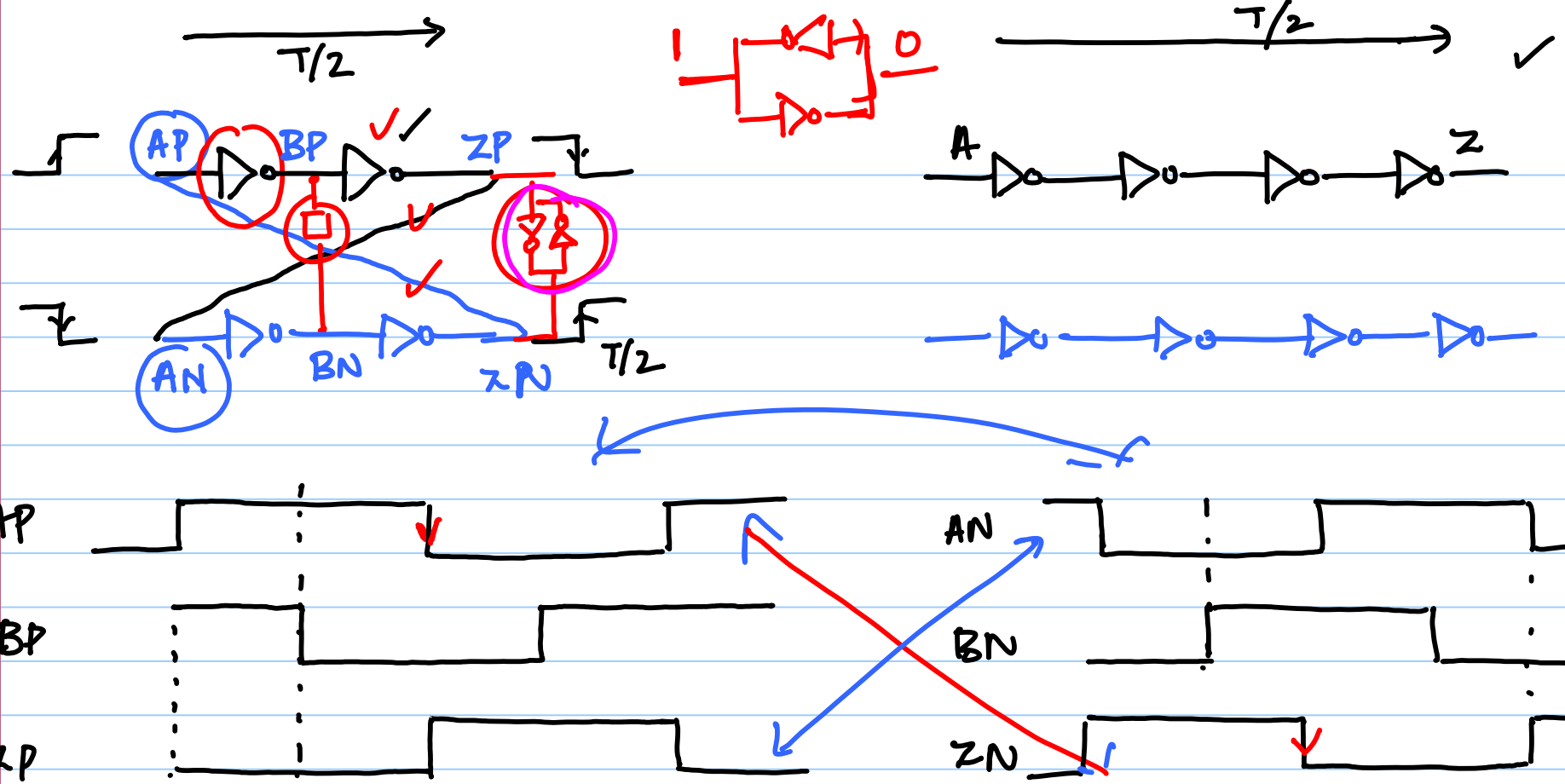
$t_{dp} = t_{dN}$



90° phase shifted.

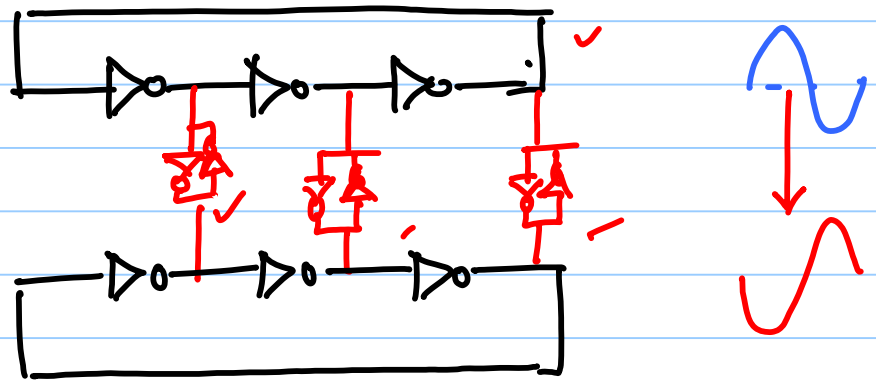
$\frac{360^\circ}{2N}$ ✓

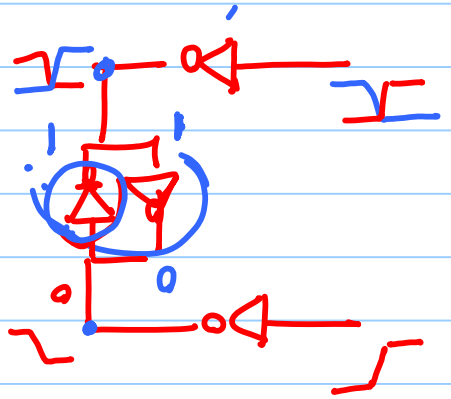


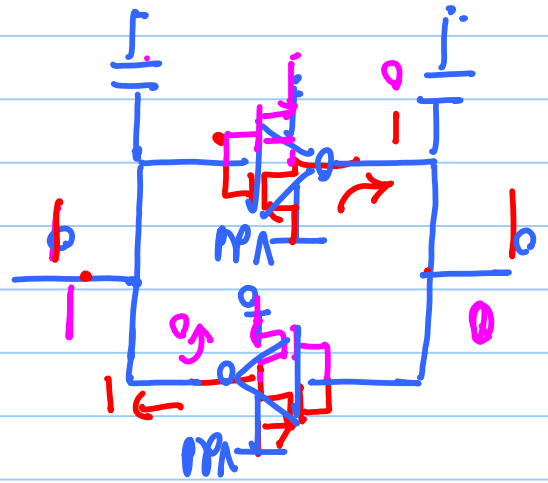


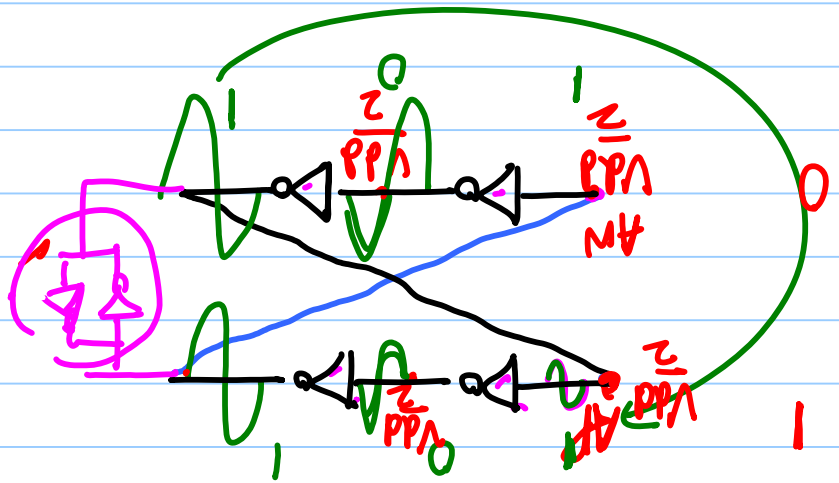
Psendo-differential Ring Osc.

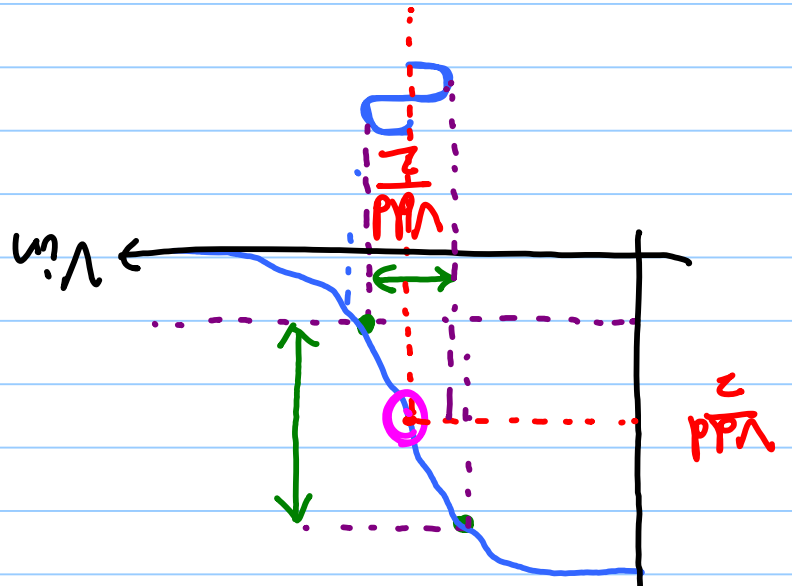
#1

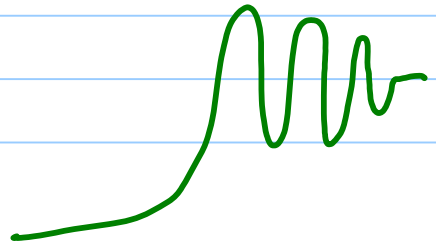


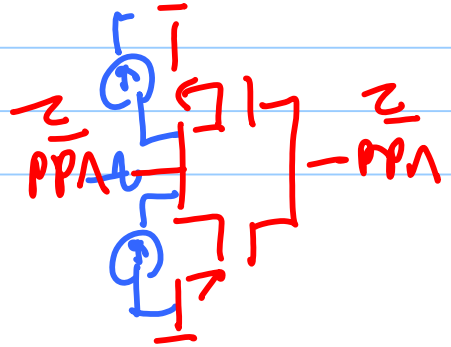


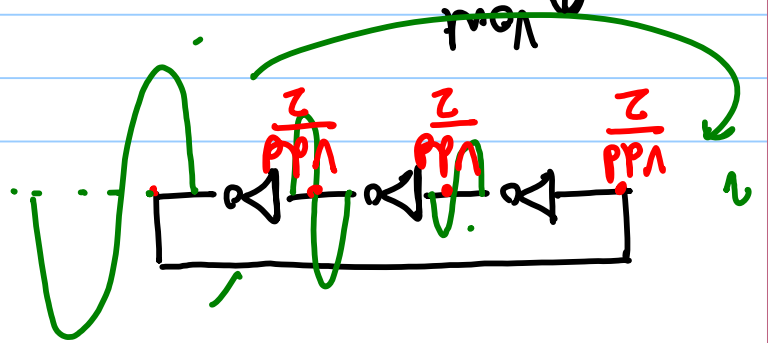


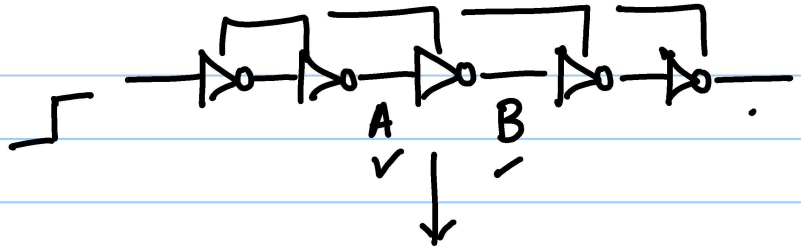






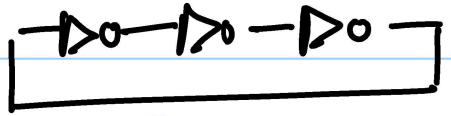




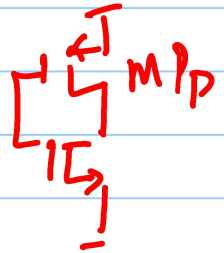


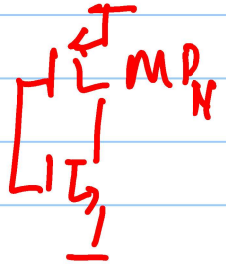
$td_{r\to f} = td_{f\to r}$

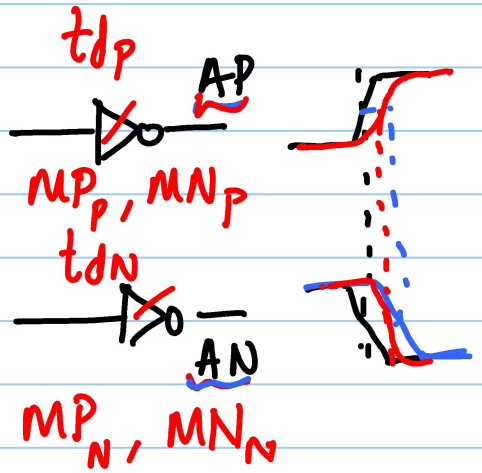
$T = 6\,td$



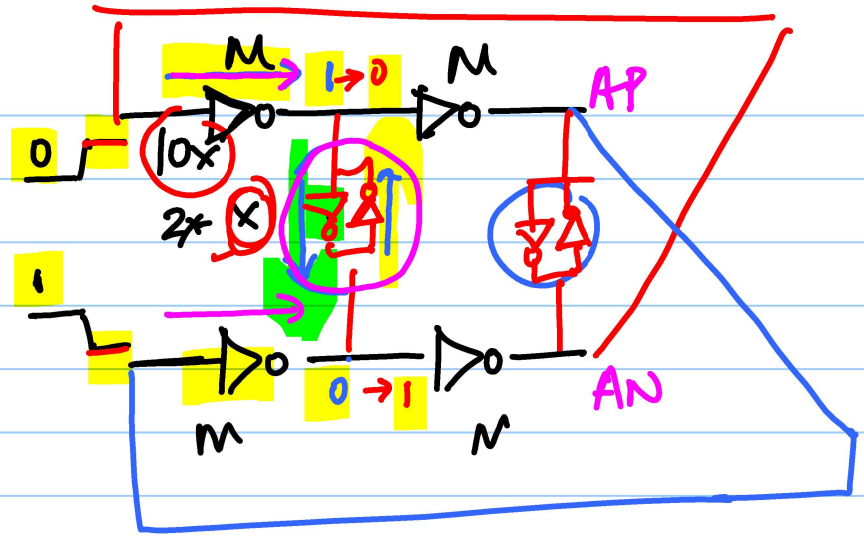
$AP = \overline{AN}$







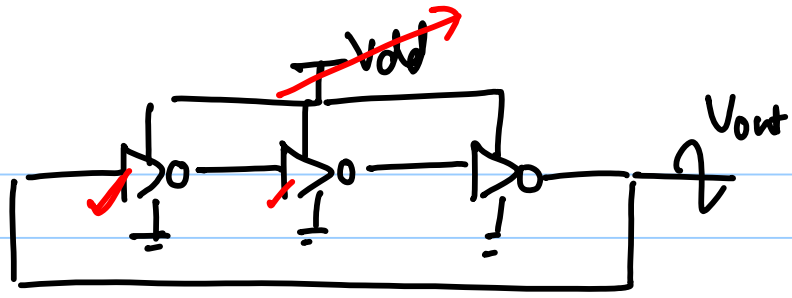
$td_P \neq td_N$



$td_{w/o\ C} < td_{w/\ C}$

⇒ large size for cross-coupled as compared to main inv.

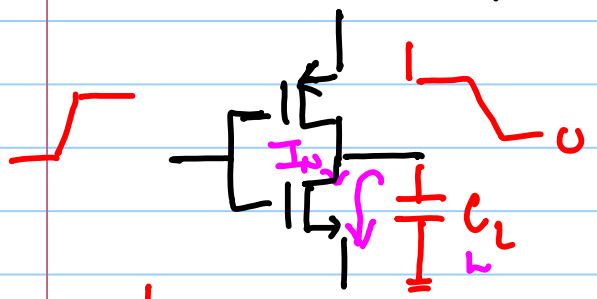
$$\text{Noise} \propto \frac{1}{\text{Power}}$$

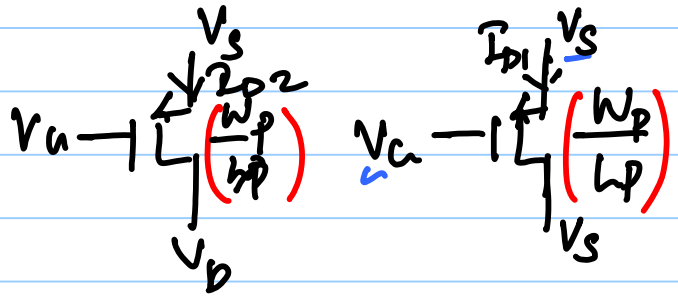


ss, tt, ff, sf, fs

fo, in "ti" : typical corner

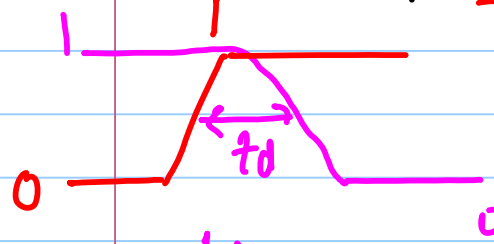
$\frac{W_p}{L_p}$, $\frac{W_n}{L_n}$



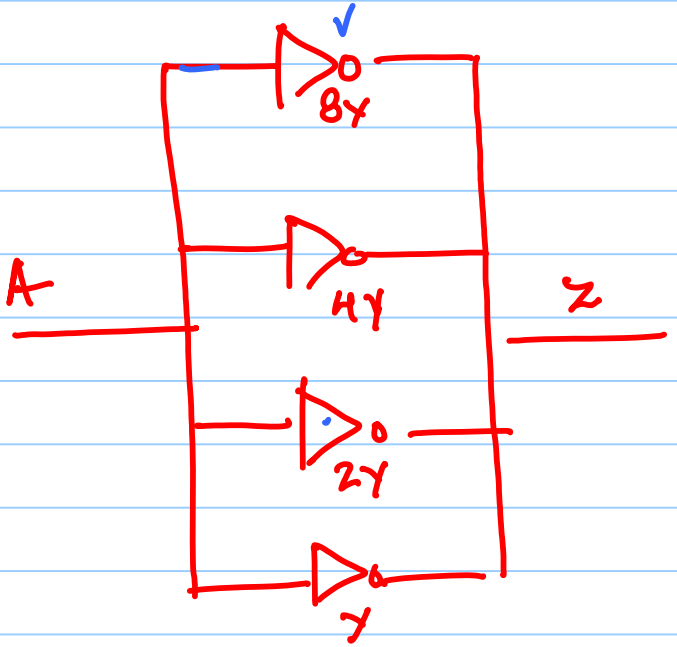


$$I_D = \mu_p C_{ox} \frac{W_p}{2L_p} (V_{sg} - |V_{tp}|)^2$$

- Mismatch
- PVT dependent.



$$\frac{1}{C} \int_0^{t_d} I_L \cdot dt = \Delta V_{out}$$



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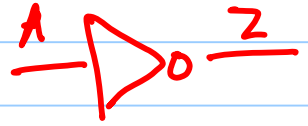
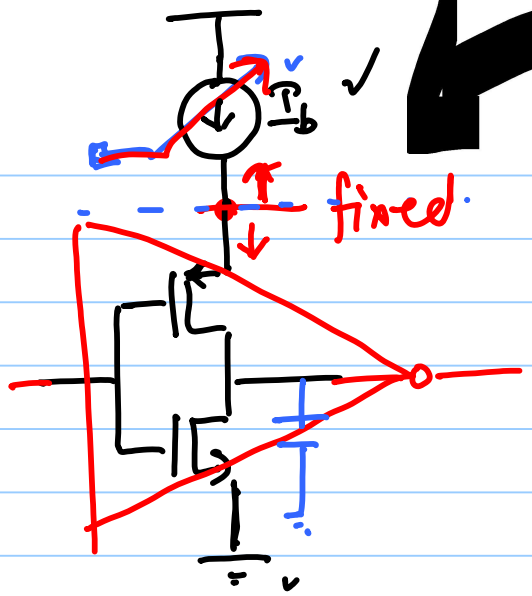
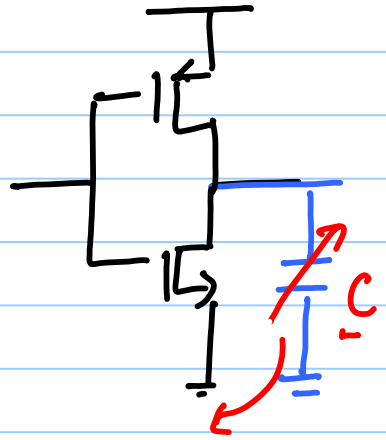


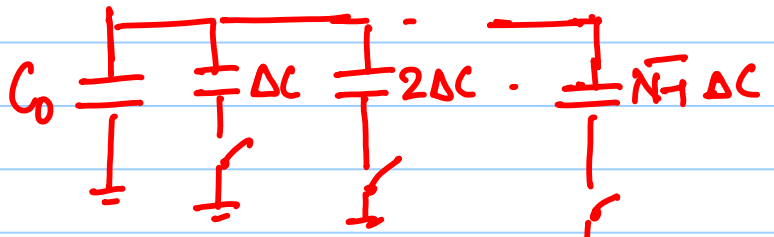
Y → 15Y

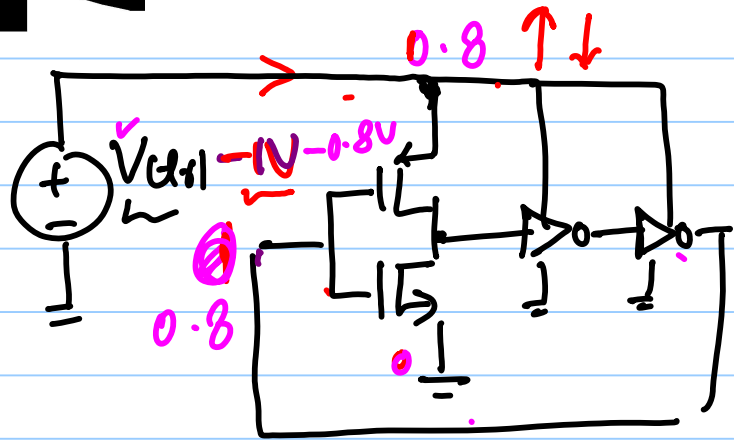
3Y ← 4Y → 13Y

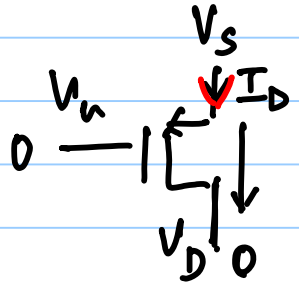


Current-starved inverter









$$I_D \uparrow = \mu_p C_{ox} \frac{W_p}{2L_p} (V_{sh} - |V_{thp}|)^2$$

Same

50mV↑ 50mV↑