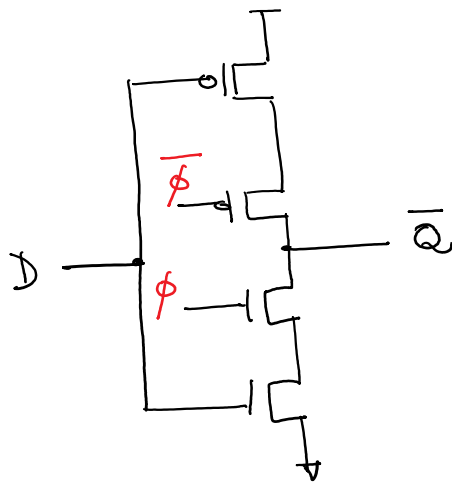


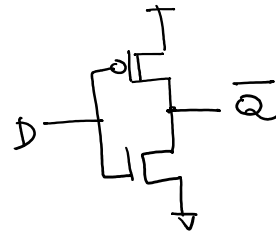
ECE 445- Lecture 25

Monday, April 29, 2019 8:04 AM

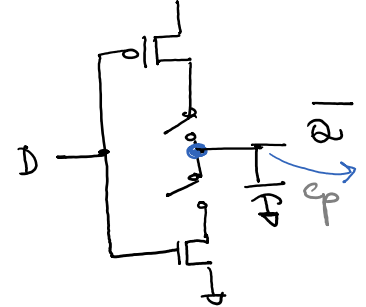
Dynamic latches:



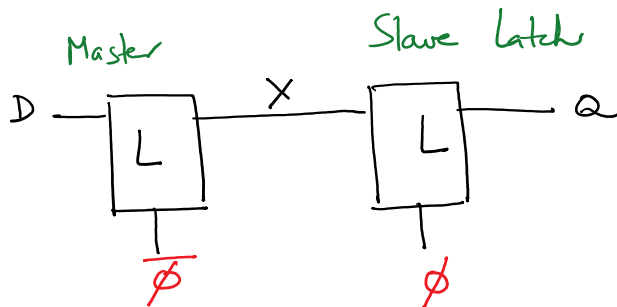
$\phi = 1$



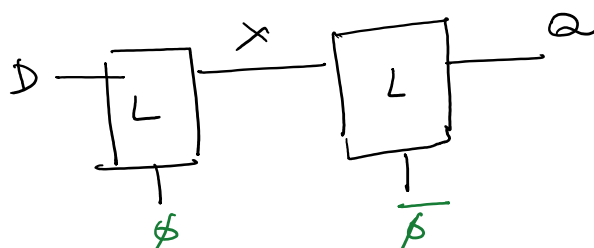
$\phi = 0$



clocked CMOS latch (C²MOS)

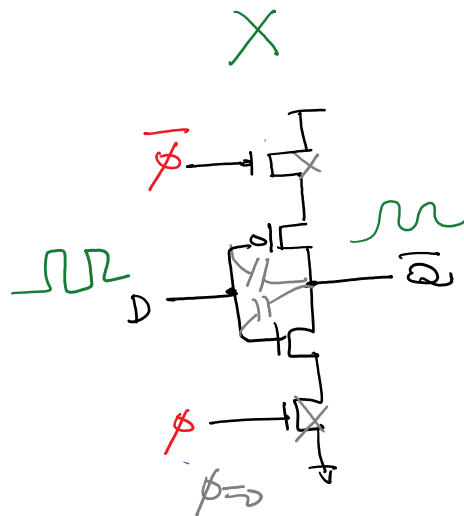
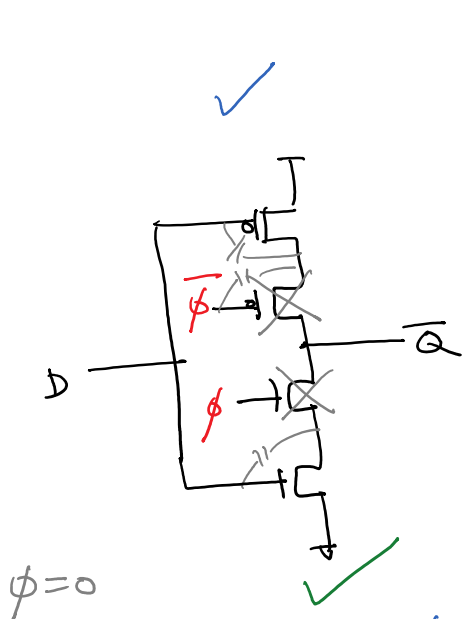
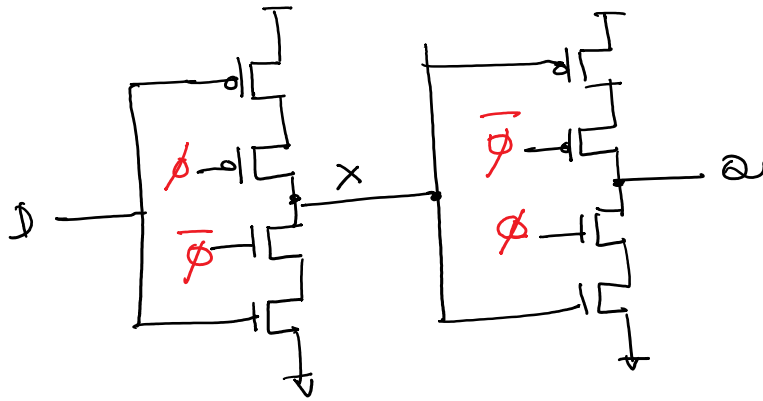


⇒ Positive edge triggered flip flop



⇒ Negative edge triggered flip flop



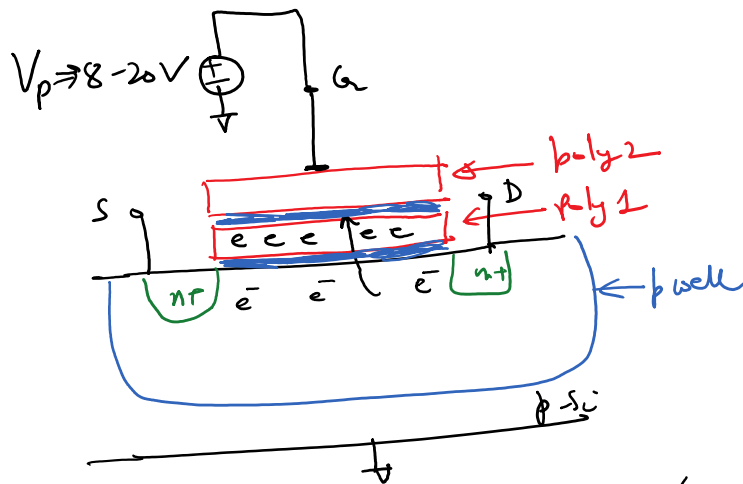


No capacitive/parasitic
feed through path
→ more robust

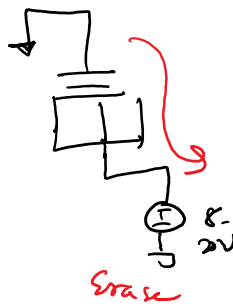
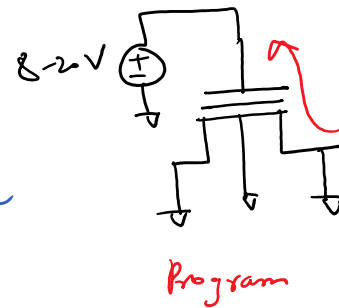
Charge Pump Design :

* A circuit that generates voltage levels higher than V_{DD} or lower than 0V (beyond the normal CMOS range).

Applications : Flash memory.

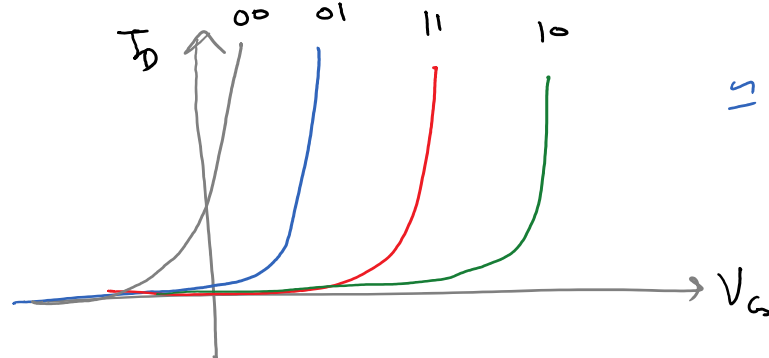


floating gate device



$$\frac{Q_{ss}}{C_{ox}} \rightarrow V_{THS} \uparrow$$

* Fowler Nordheim Tunneling (FNT)

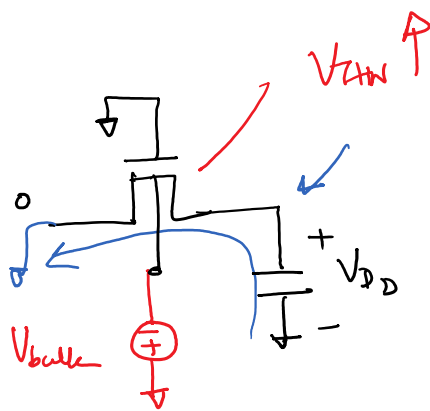
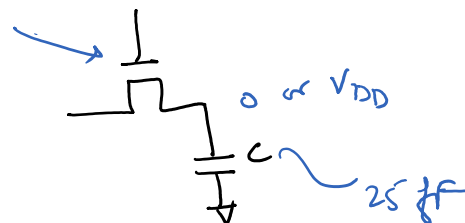
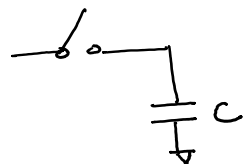


$\approx 10^5$ cycles

$\Rightarrow$ Non volatile memory (NVM)
L, TB

DRAM (volatile memory)

access transistor 1T1C cell



reduce leakage by increasing

V_{thn}

→ use body effect

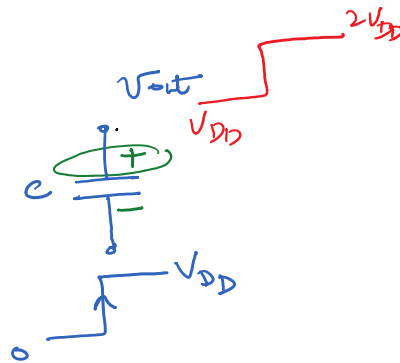
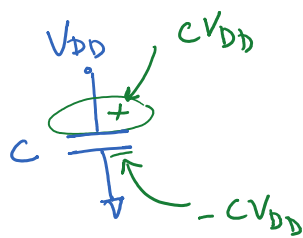
$$V_{SB} \uparrow \Rightarrow V_{thn} \uparrow$$

use negative body voltage $\approx \underline{\underline{-0.5V}}$

* shouldn't turn on the Drain/Source diodes

* CMOS book Chapter 16 → read more on Memory IC's

Basic Concept $\rightarrow$ Doubler doubler

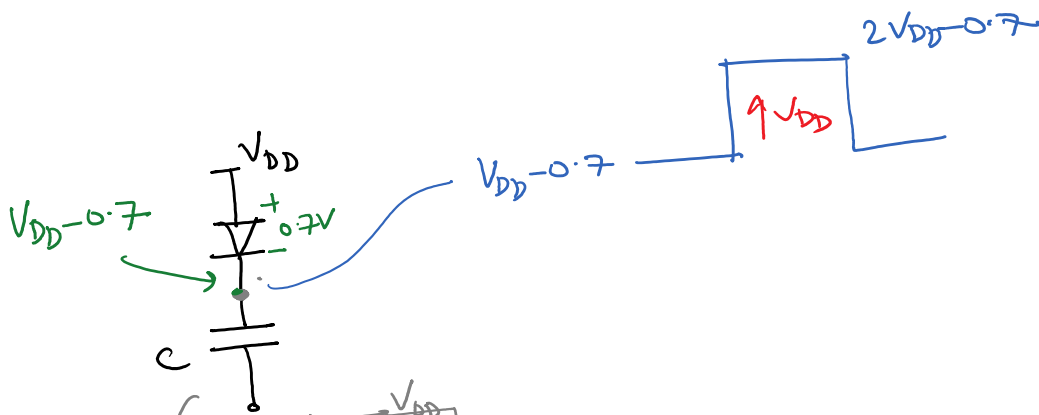
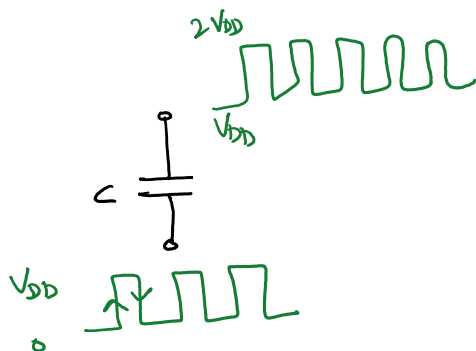


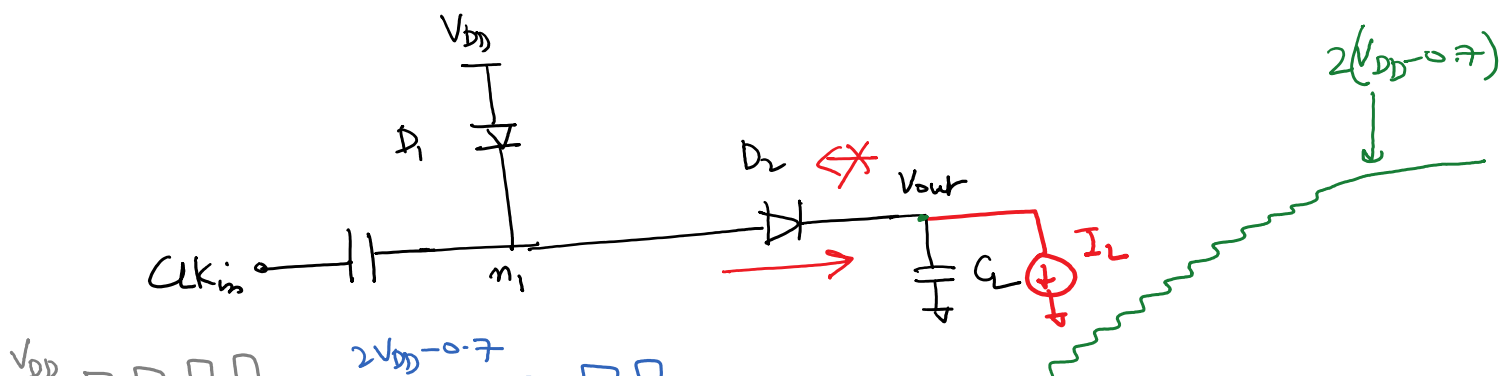
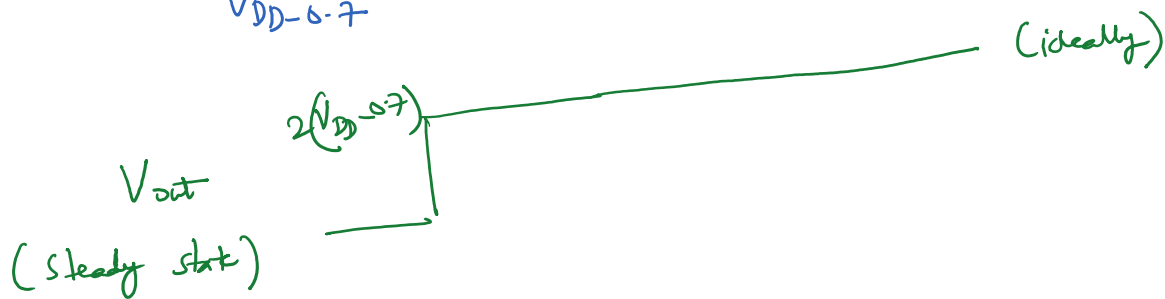
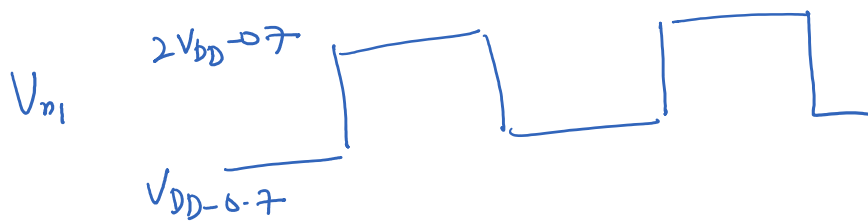
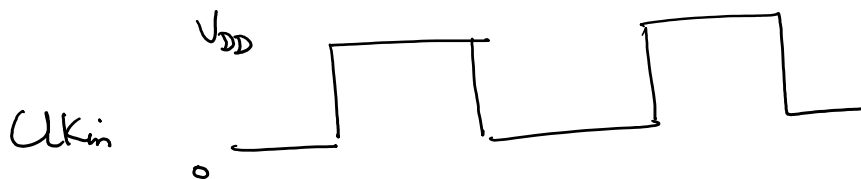
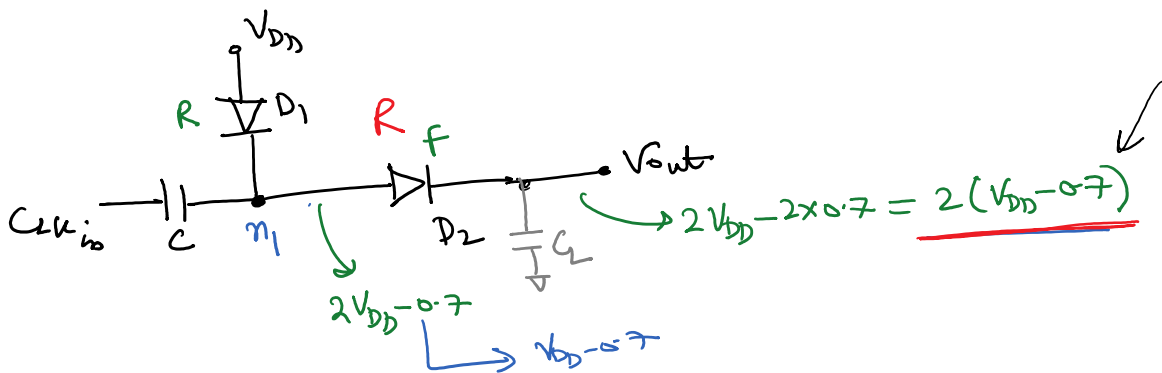
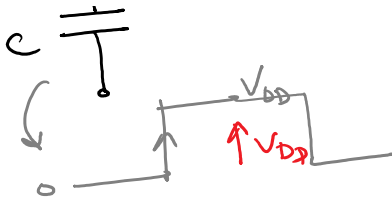
charge is conserved $\Rightarrow$ no discharge path for the charge

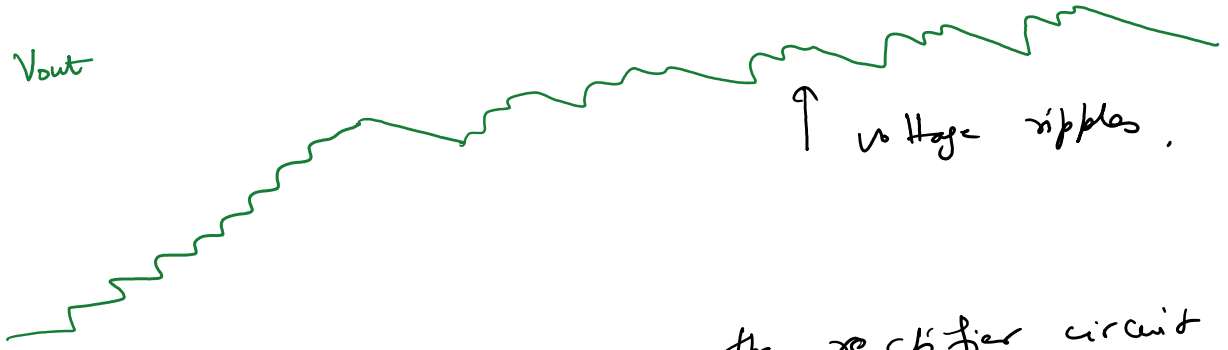
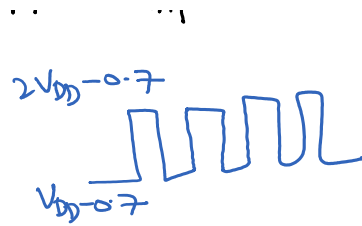
$$\Rightarrow Q_{final} = Q_{initial}$$

$$\Rightarrow C(V_{out} - V_{DD}) = C(V_{DD} - 0)$$

$$\Rightarrow V_{out} = 2V_{DD}$$



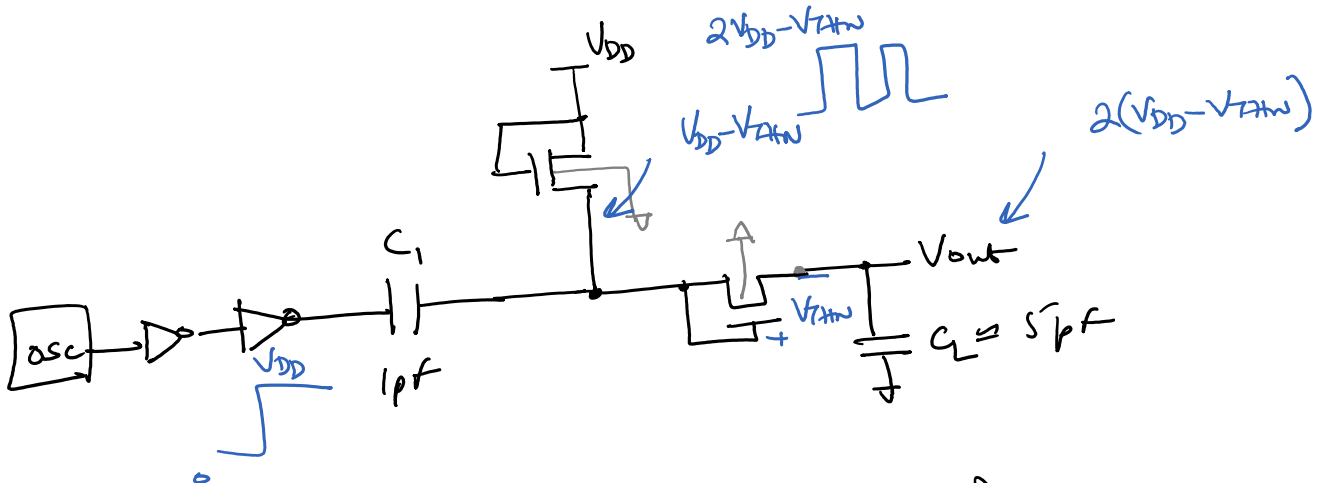
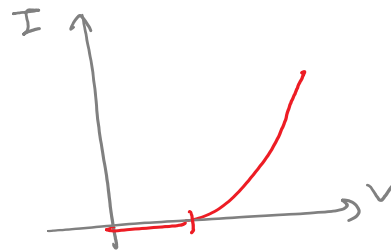
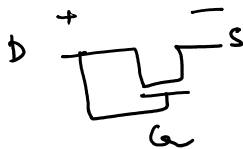
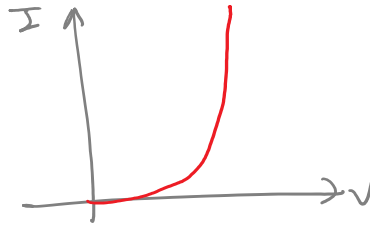
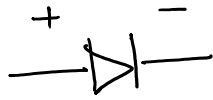




↑ voltage ripples.

Similar behaviour as the rectifier circuit

CMOS Charge Pump :



$$V_{out} = 2(V_{DD} - V_{thn})$$

$$V_{SB} > V_{DD}$$

⇒ Large body-effect

x Can use PMOS diodes with Source & bulk connected

to reduce body effect

$$V_{out} = 2(V_{DD} - V_{THS})$$
$$= 8V$$

$$V_{DD} = 5V$$
$$V_{THS} = 1V$$

* For $V_{out} = 20V$?

