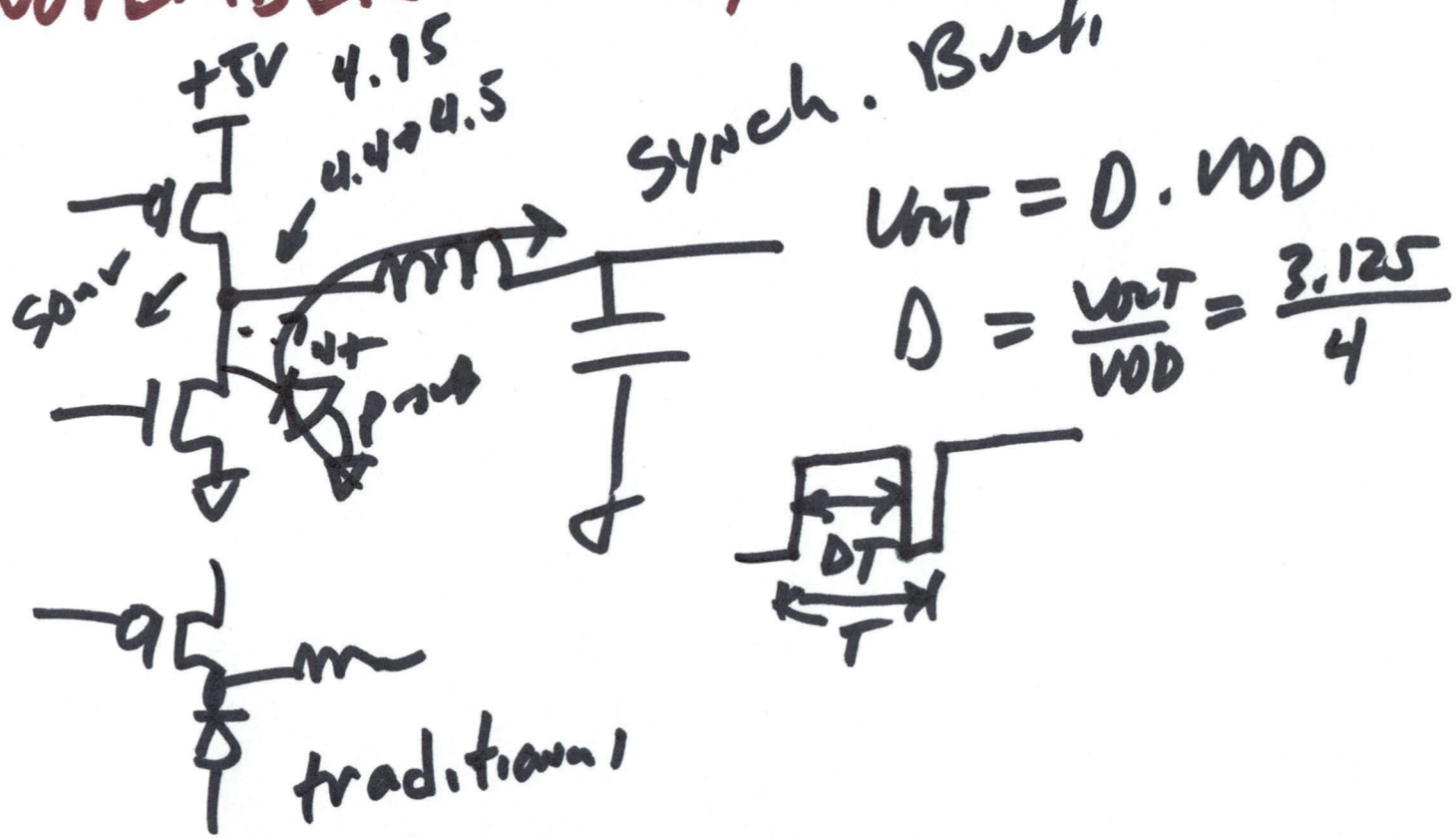
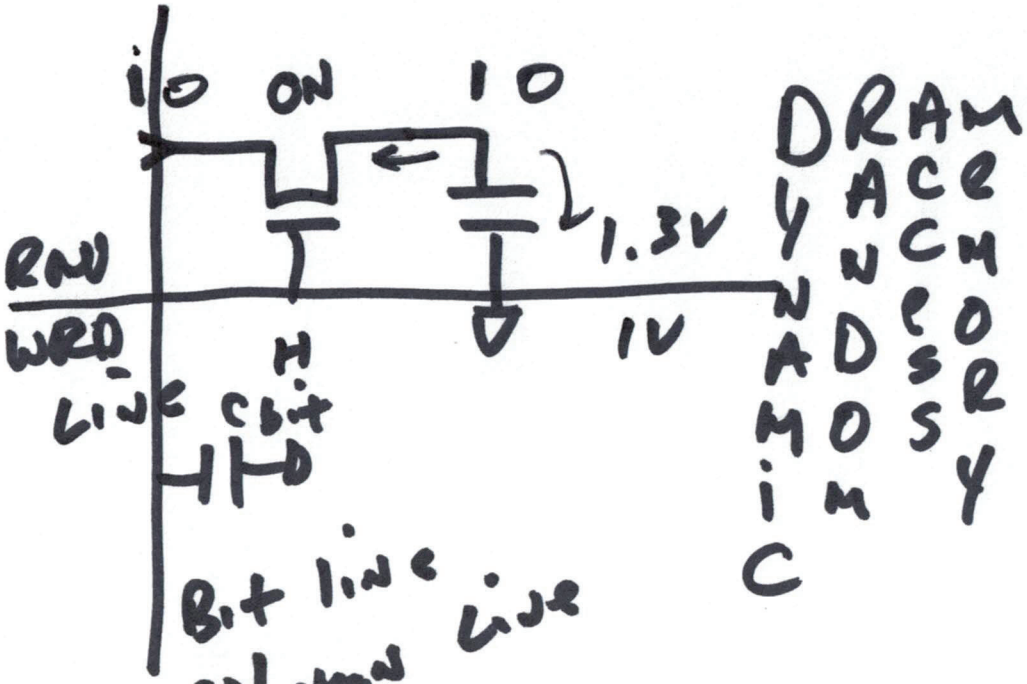
EE 421 / ECG 621
Digital IC Design
Lecture 24
NOVEMBER 27, 2023



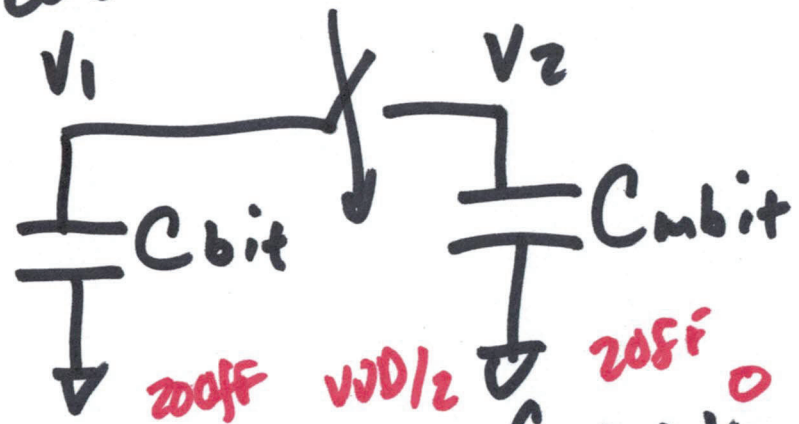


DRAM → computer

DYNAMIC RANDOM ACCESS MEMORY

DDR

Double data rate



Charge sharing

$CV = Q$

$C_{bit} \cdot V_1 + C_{mbit} \cdot V_2 =$

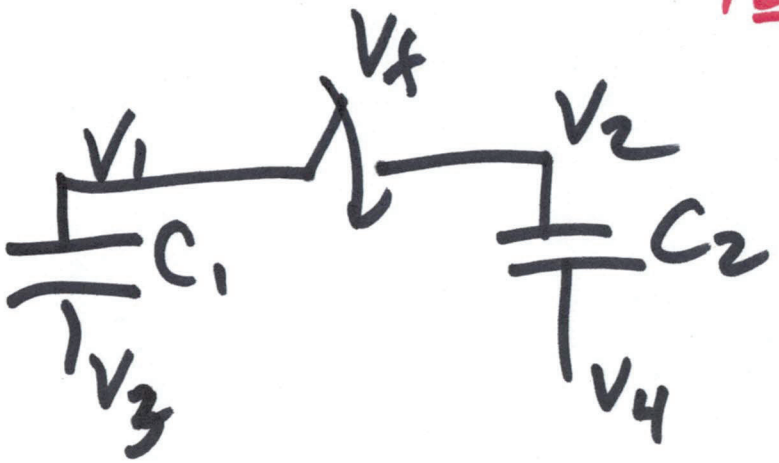
$V_f (C_{bit} + C_{mbit})$

$$V_f = \frac{C_{bit} \cdot V_1 + C_{mbit} \cdot V_2}{C_{bit} + C_{mbit}}$$

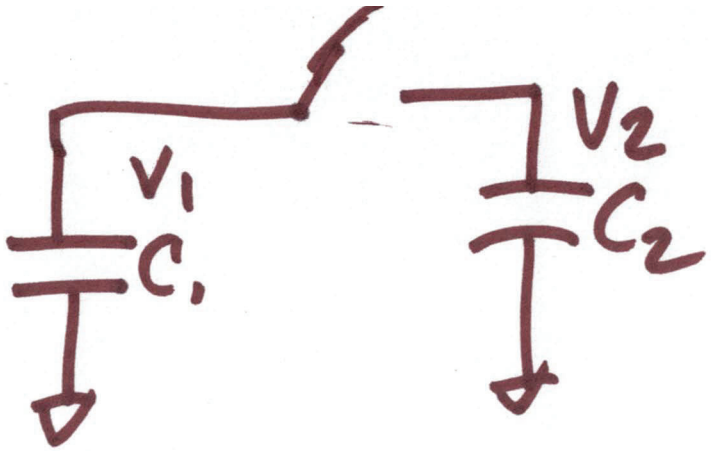
C_{bit}: 200ff, C_{mbit}: 20ff

$\frac{200}{220} \cdot \frac{VDD}{2} \rightarrow \frac{1}{2}V$

$1/2 \rightarrow 454\,mV$, $46\,mV$



$$C_1(V_1 - V_3) + C_2(V_2 - V_4) = C_1(V_f - V_3) + C_2(V_f - V_4)$$

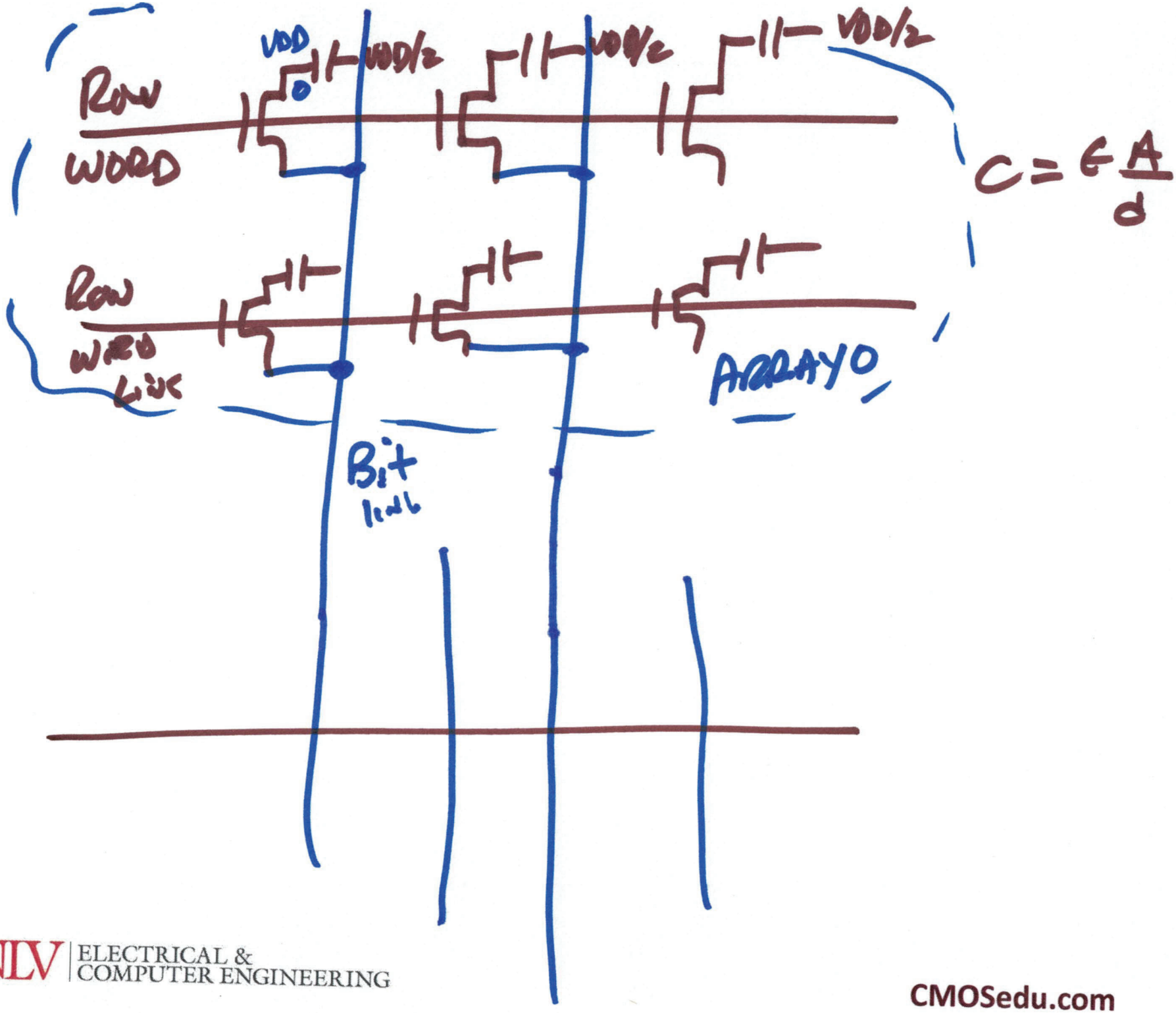


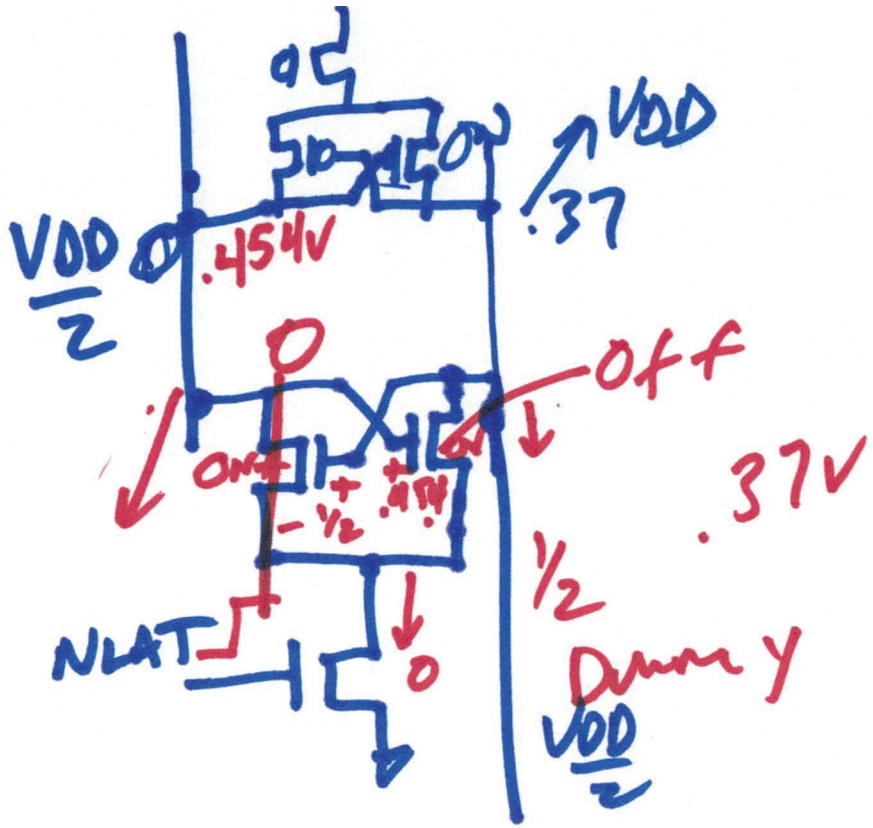
$$\mathcal{E} = \frac{1}{2}CV^2$$

$$\frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2 = \frac{1}{2}\cancel{(C_1+C_2)}\cdot\left(\frac{V_1C_1+V_2C_2}{\cancel{C_1+C_2}}\right)^2$$

$$= \frac{1}{2}\frac{C(V_1C_1+V_2C_2)^2}{C_1+C_2}$$

$$V_f = \frac{V_1C_1+V_2C_2}{C_1+C_2}$$


VDD
VDD/2
VDD/2
VDD/2
Row
WORD
Row
WORD
LINE
Bit
line
ARRAY0
$C = \epsilon \frac{A}{d}$


VDD
.37
VDD/2
.454V
off
.37V
NLAT
1/2
Dummy
VDD/2