EE 421 / ECE 621

Dec. 4, 2013

Lecture 27

Review for Final

$C_{ox}' = \frac{\varepsilon_{ox}}{t_{ox}}$ ↙ TOX

Parameters from SPICE

100nA/V²
50nA/V²
KP ↗

Level 3

10, 3µ ↗

VTO V_{SG} V_{SD}

KP

$I_D = \frac{KP}{2} \cdot \frac{W}{L} (V_{GS} - V_{THN})^2$ pmos

↘ VTO

300N

↘ 2

600N

0.6µ

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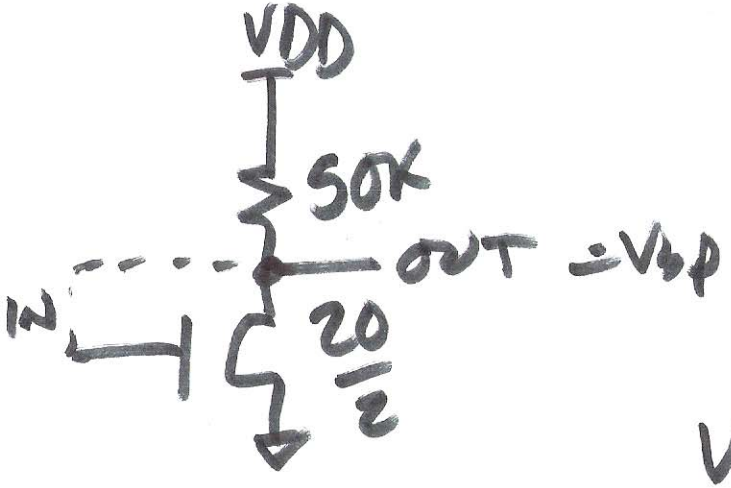
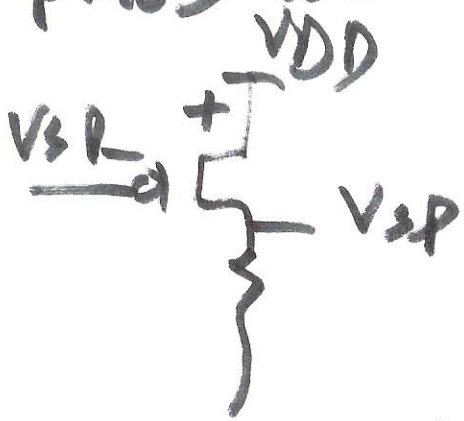


V_{SP}, V_{OH}, V_{OL}
state assumptions

$$\frac{V_{DD} - V_{SP}}{50K} = \frac{20}{2} \cdot \frac{KP}{2}\left(V_{SP} - V_{THP}\right)^2$$

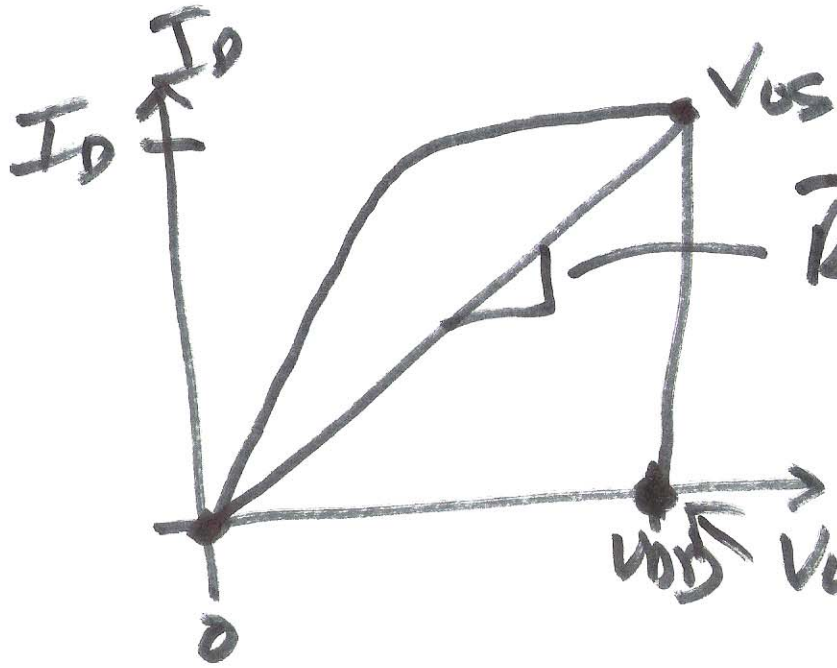
$V_{THP} \rightarrow V_{TO}$

PMOS too



$$V_{SG} = V_{DD} - V_{SP}$$

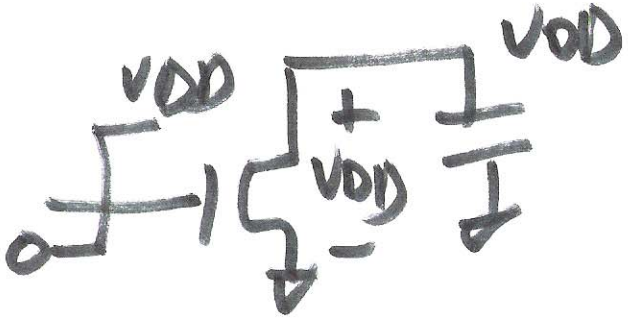
Calculate R_N', R_P', C_{ox}'



$$R_N' = \text{slope} = \frac{I_D}{VDD}$$

$$R_N = R_N' \cdot \frac{L}{W}$$

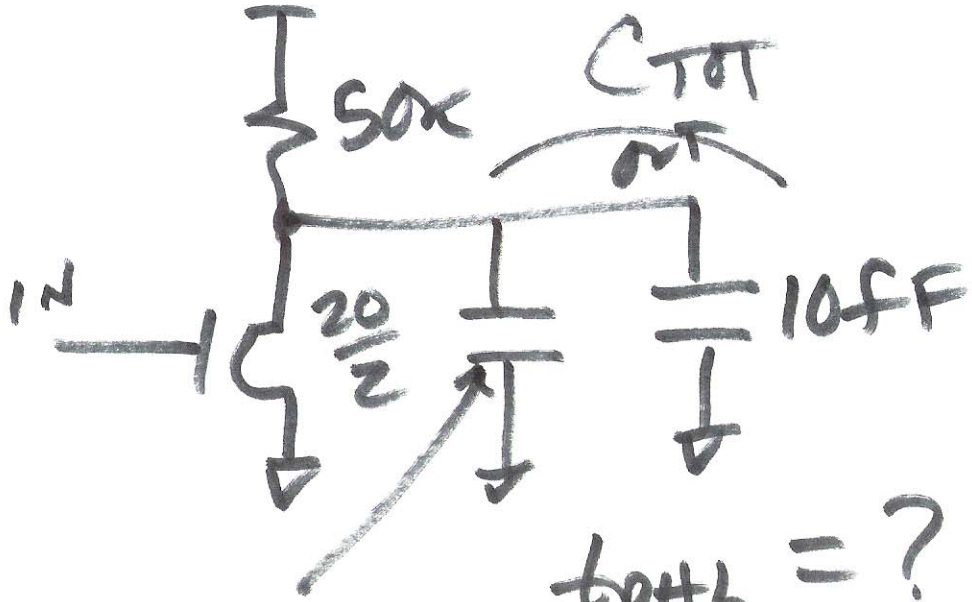
$V_{DS} = VDD$



$$R_N = \frac{VDD}{\frac{KP}{2}\cdot\frac{W}{L}\left(VDD - V_{TN}\right)^2}$$

$$R_N' = \frac{VDD}{\frac{KP}{2}\left(VDD - V_{TN}\right)^2}$$

PMOS too



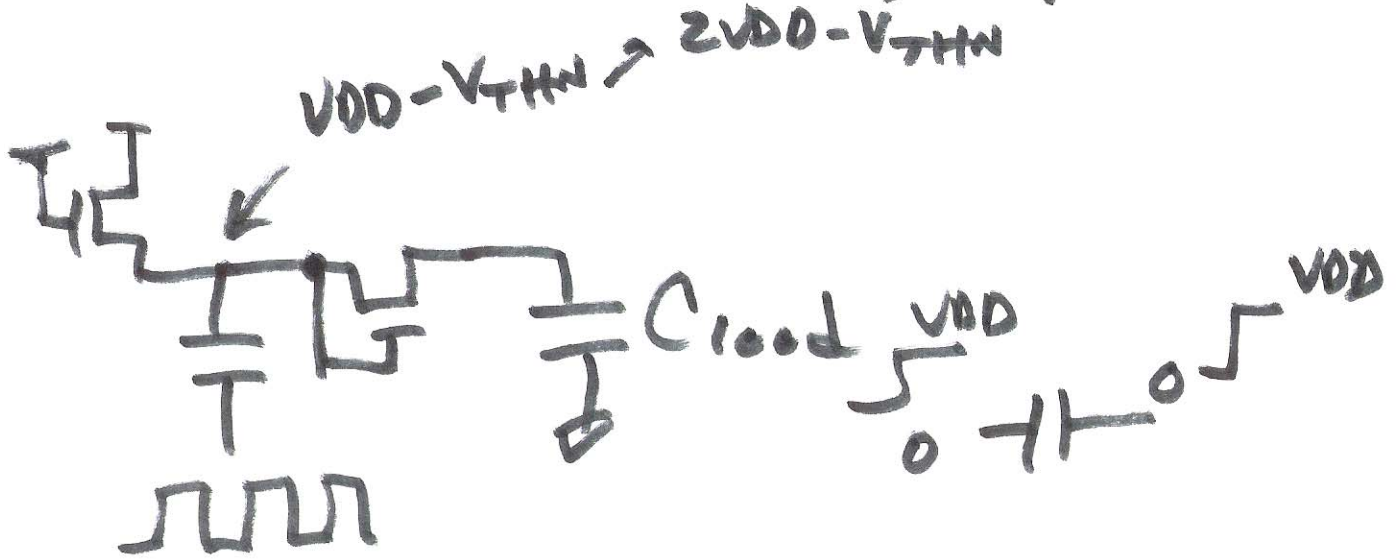
C_{ox} =

$W \cdot L \cdot C'_{ox} \cdot (Scale)^2$

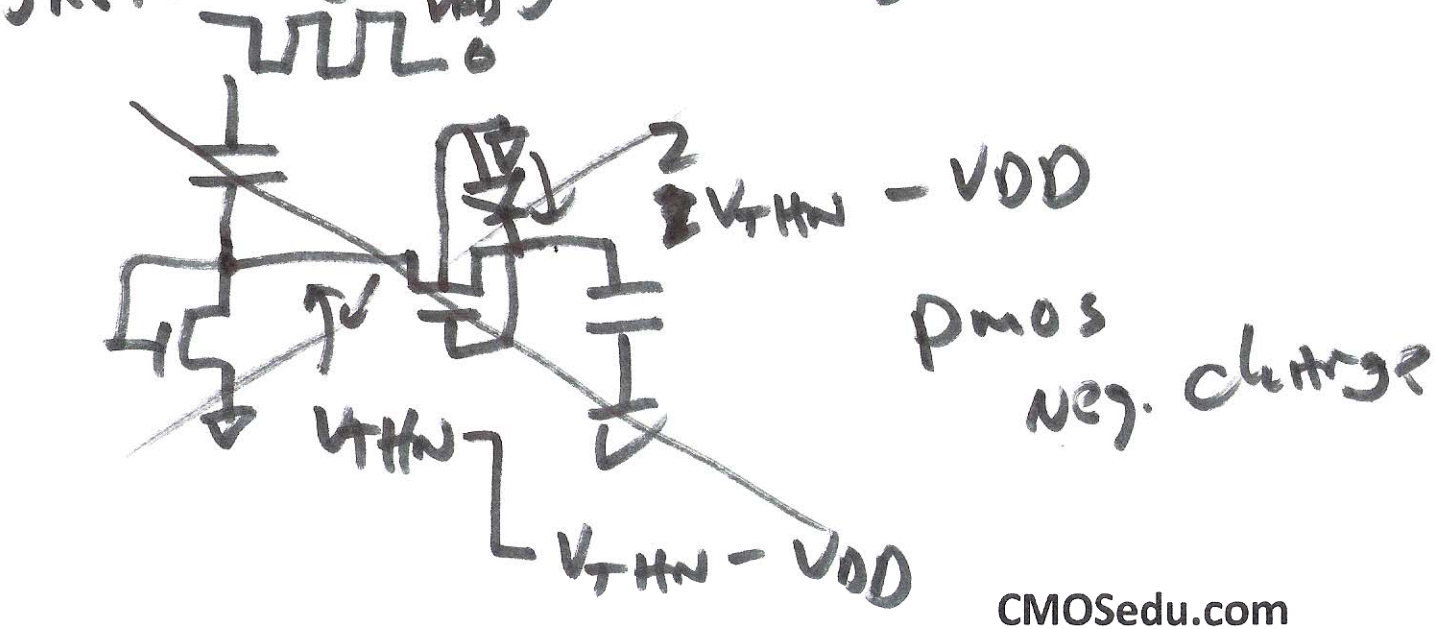
$t_{pHL} = ? = 0.7 R_N C_{TOT}$

$t_{pLH} = ? = 0.7 \cdot SOx \, C_{TOT}$

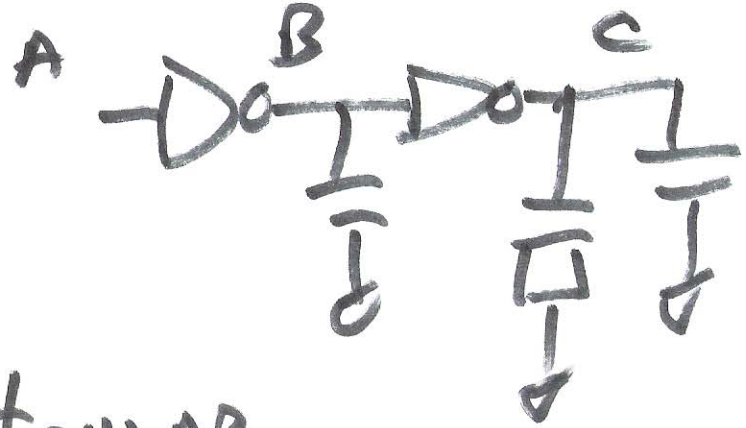
Sketch a schematic for pos. charge pump



Sketch a neg. charge pump



Estimate delays



t_{PHLAB}
$PLHBA$

Sketch the schematic of an edge triggered D-FF

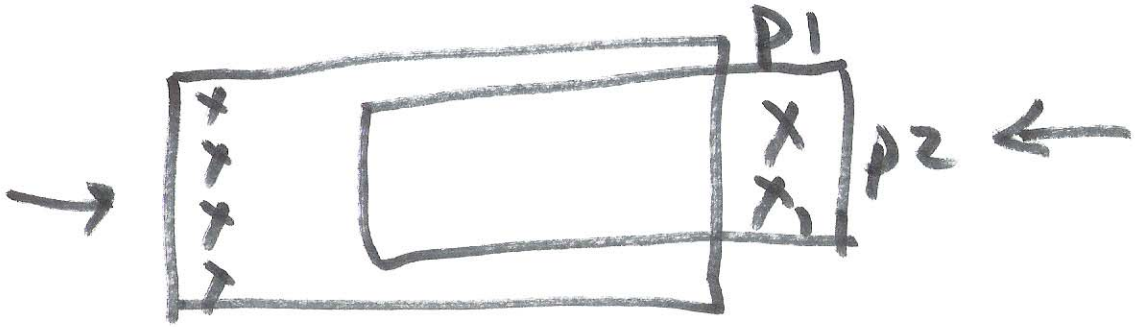
$\bar{A}B + \bar{B}A = ?$ XOR

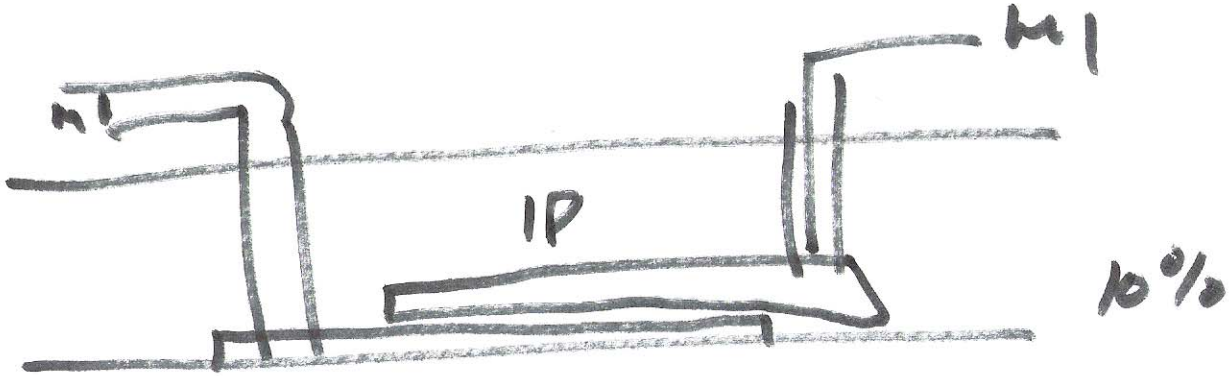
$A + CB$

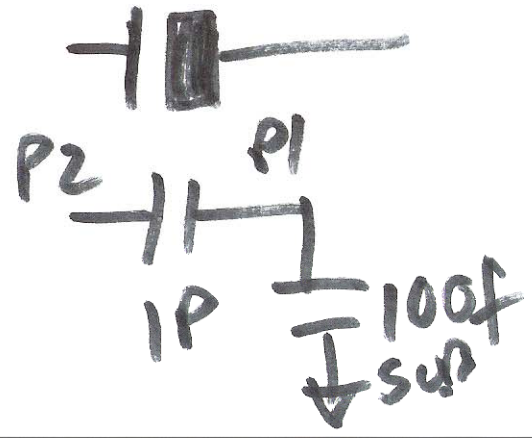
$\overline{A \cdot B}$

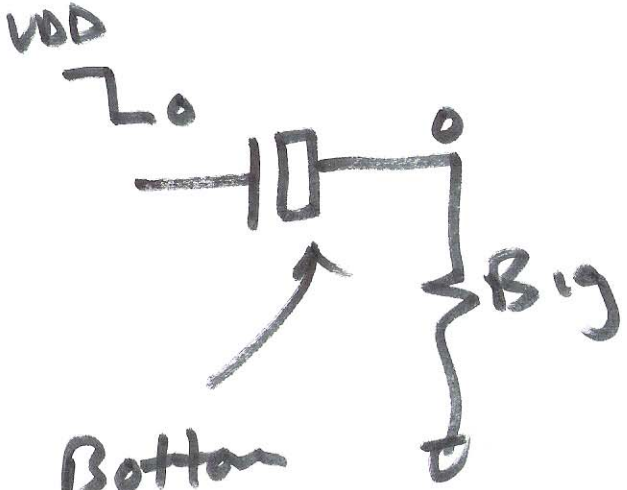
Layout → Schematic

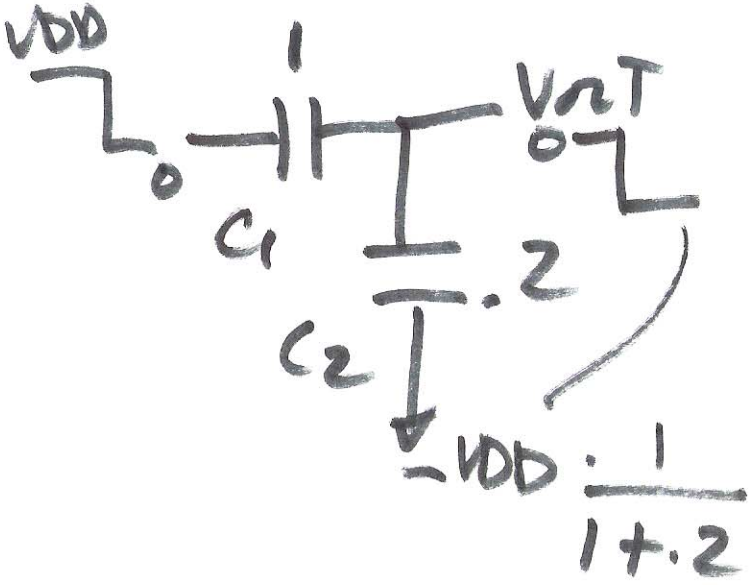
Poly1-Poly2 CAP

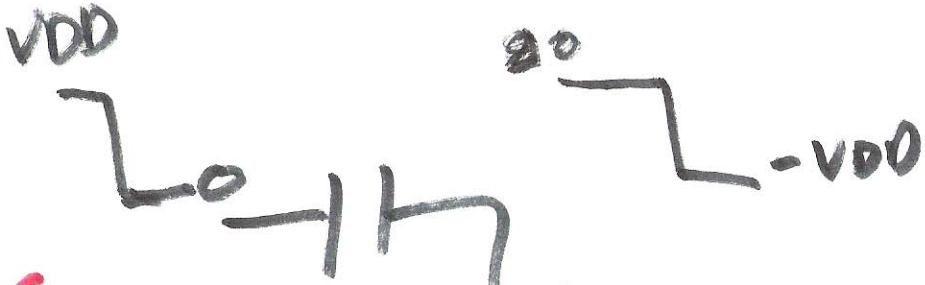


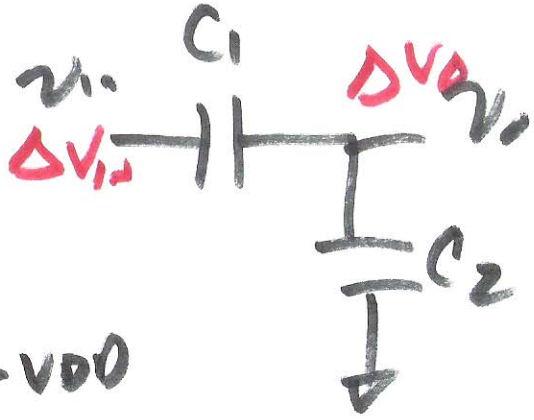












$(\Delta V_{IN} - \Delta V_O) C_1 = \Delta V_O \cdot C_2$

$\Delta V_{IN} C_1 = \Delta V_O \cdot (C_1 + C_2)$

$\frac{\Delta V_O}{\Delta V_{IN}} = \frac{C_1}{C_1 + C_2}$

$v_o = v_{in} \cdot \frac{\frac{1}{j\omega C_2}}{\frac{1}{j\omega C_2} + \frac{1}{j\omega C_1}}$

$\frac{v_o}{v_{in}} = \frac{C_1}{C_1 + C_2}$

8)

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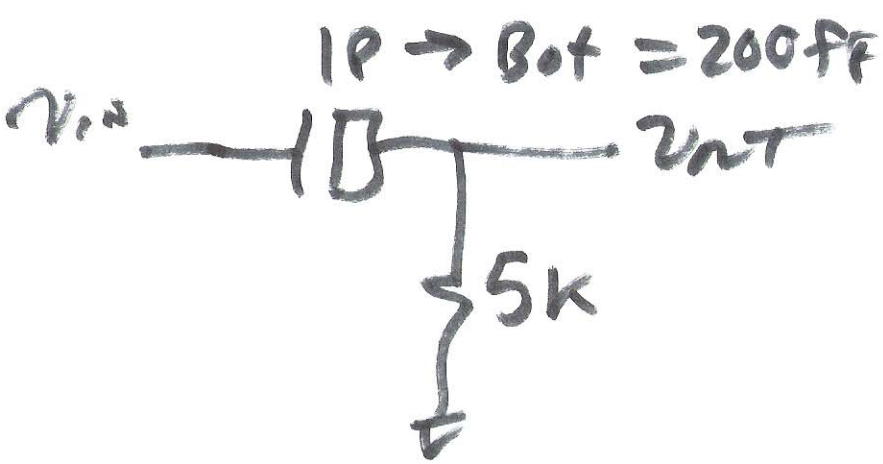

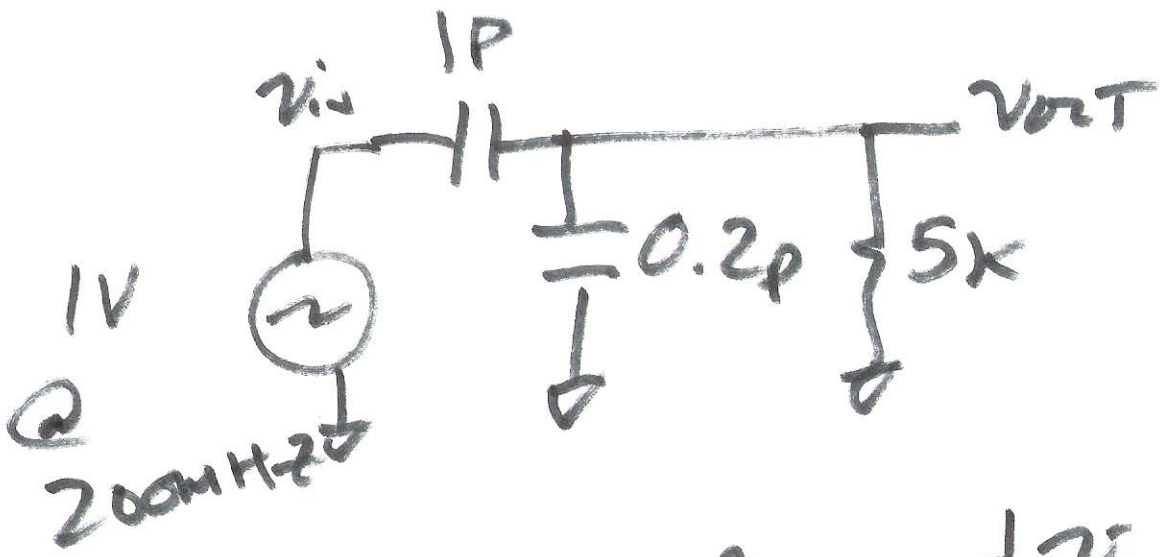

plot

$\left|\frac{V_{out}}{V_{in}}\right|$ v. f

$\angle \frac{V_{out}}{V_{in}}$ v. f

Bode plot

Sketch V_{out} & V_{in} on the same plot

$|\ |$ $\angle \rightarrow$ t1

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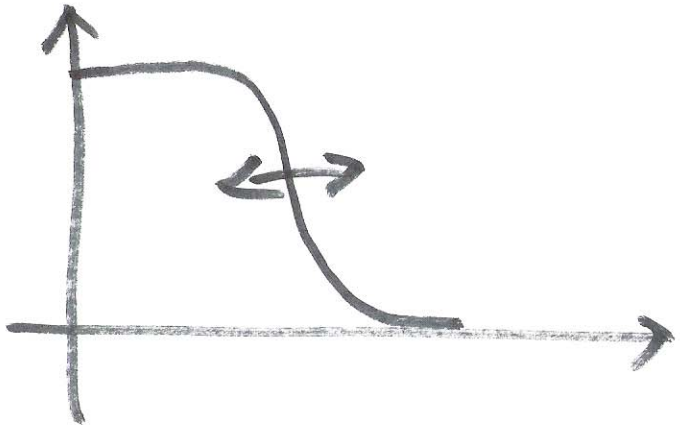
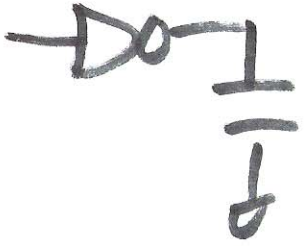
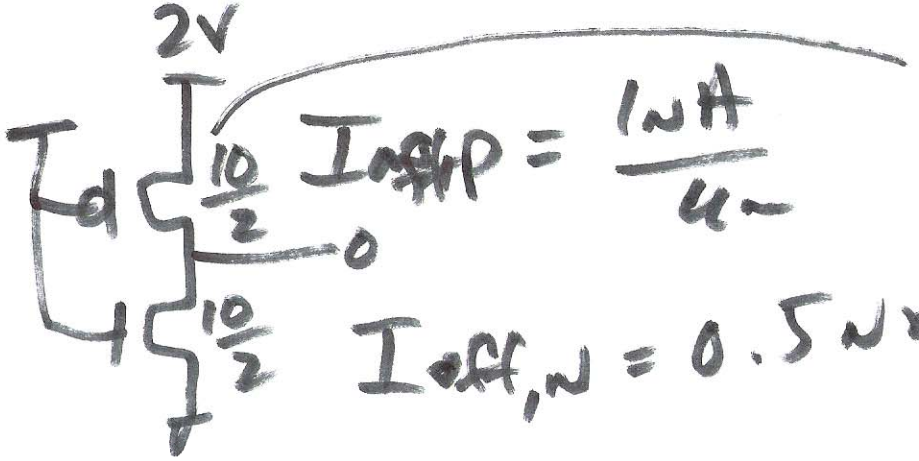
Switching point voltage

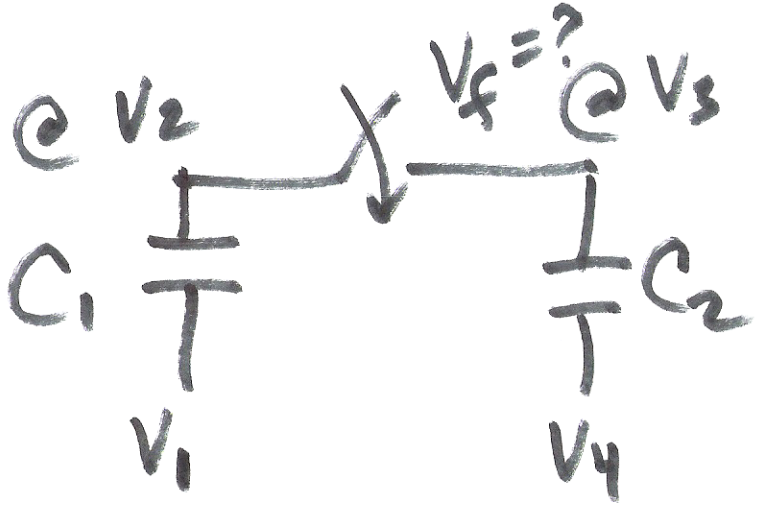
$S \cdot A + \bar{S} B = Z$





on & off currents & how relate to power





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

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

$$V_f = \frac{C_1 V_2 + C_2 V_3}{C_1 + C_2} = V_f(C_1 + C_2)$$

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