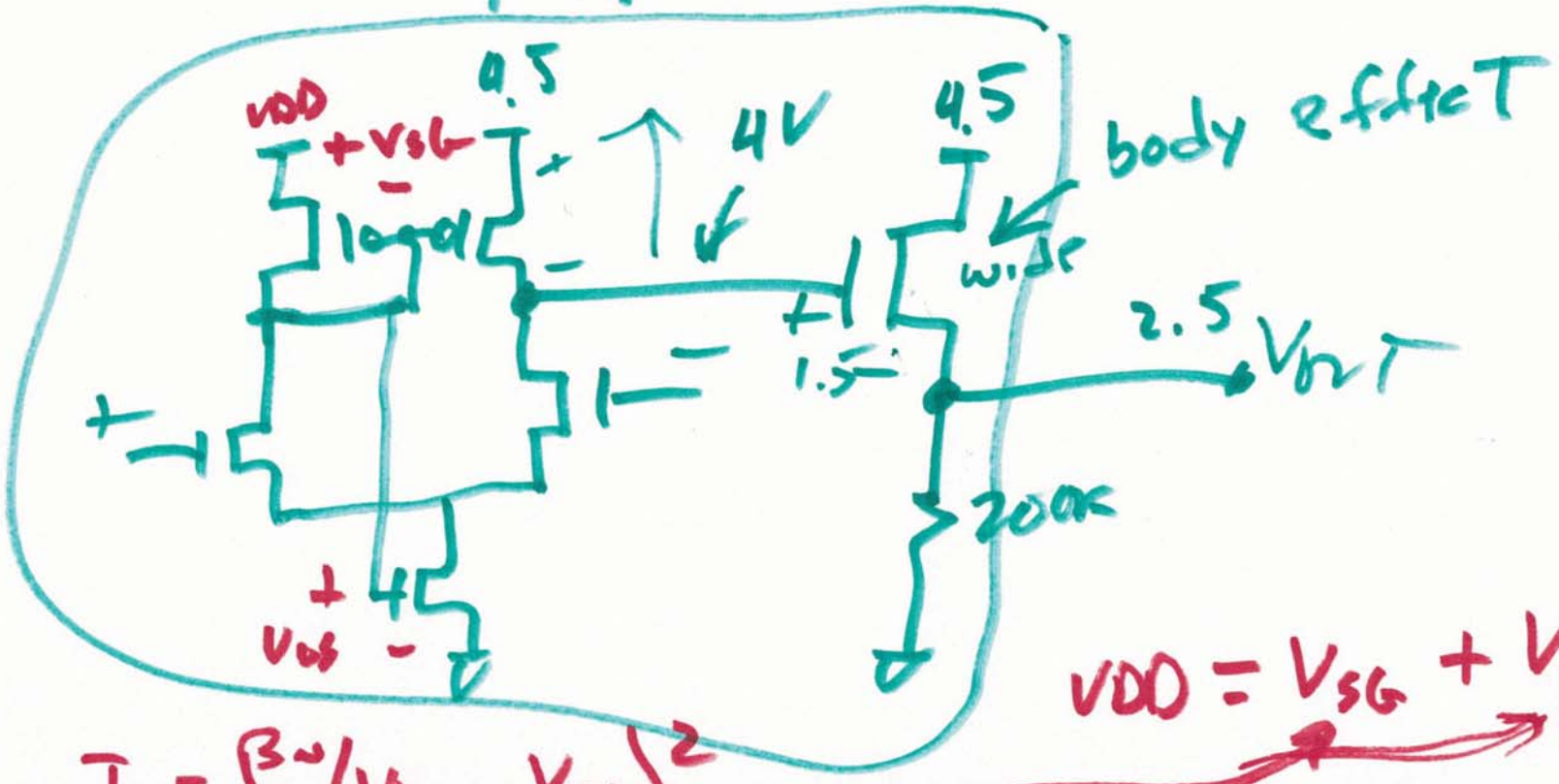
EE 421 / ECG 621
Digital IC Design
12/2/15



$$I_D = \frac{\beta}{2}(V_{DS} - V_{THN})^2$$

$$V_{DD} = V_{SG} + V_{DS}$$

$$V_{DS} = \sqrt{\frac{2I_D}{\beta}} + V_{THN}$$

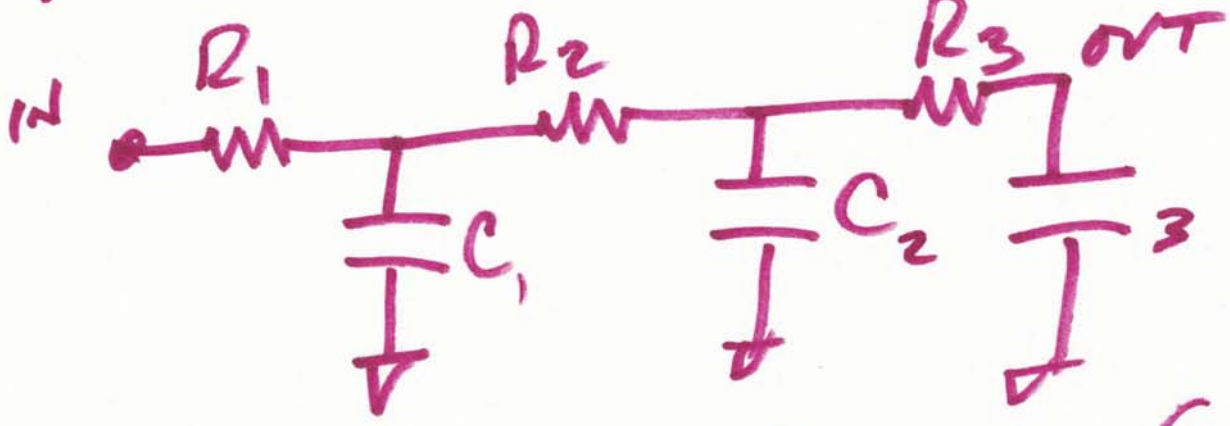
study H.W. & Quizzes ←

1) RC, RL, Similar to Ex. in cl. 1

2) PN → depletion cap MJ, sidewall
Built-in potential

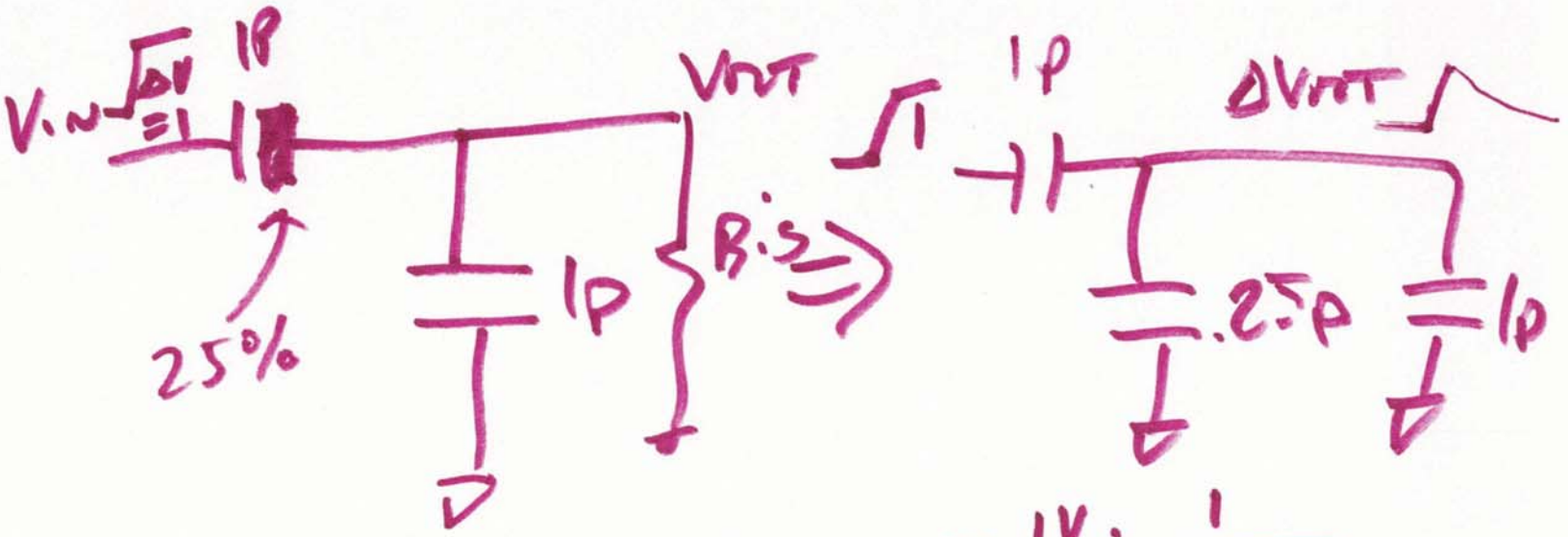
3) Layout substrate, well contacts
parasitic PNP

4) rcl^2 .35 (deriving) $R_1 \neq R_2 \neq R_3$



$$0.7\left(R_1C_1 + (R_1+R_2)C_2 + (R_1+R_2+R_3)C_3\right)$$

poly - poly capacitor



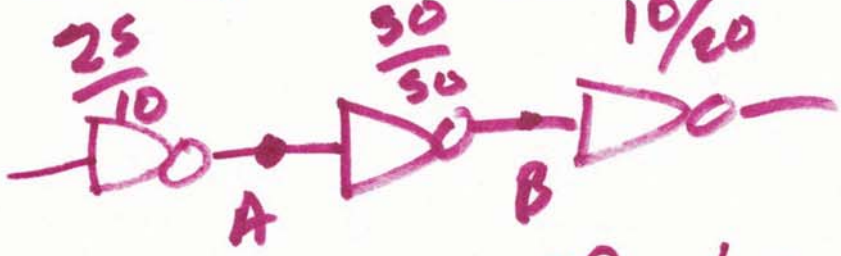
$$\Delta V_{out} = 1V \cdot \frac{1}{1+.25+1}$$

Delay Calculations, 1u

$R_n' = 75k$

$R_p' = 45k$

$C_{ox}' = 1.75 \frac{fF}{\mu m}$



$$t_{pLH} = \overset{0.7}{R_p'} \cdot \frac{1}{50}\left(C_{ox}' \cdot 50 \cdot 1 + C_{ox}' \cdot 50 \cdot 1 + \frac{3}{2} C_{ox}' \cdot 10 \cdot 1 + \frac{3}{2} C_{ox}' \cdot 20 \cdot 1\right)$$

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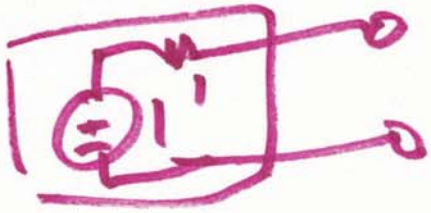
Ring oscillators

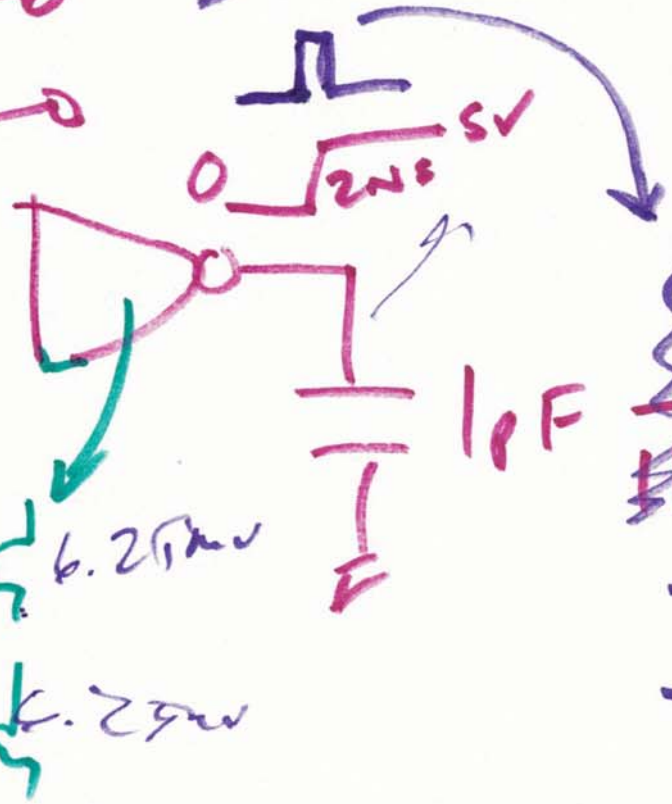


Power ⌐ VDD
freq.
I current

$\frac{1}{I}$ ESR

$I = 2.5\,mA$

$I = C\frac{dV}{dT}$



$I = 1p \cdot \frac{5}{2ns} = 2.5m$

Project questions

How do you calculate the cap in the charge pump?

Explain in your own words how the pump works.

→ inverter switching point ←

Layout of inverT

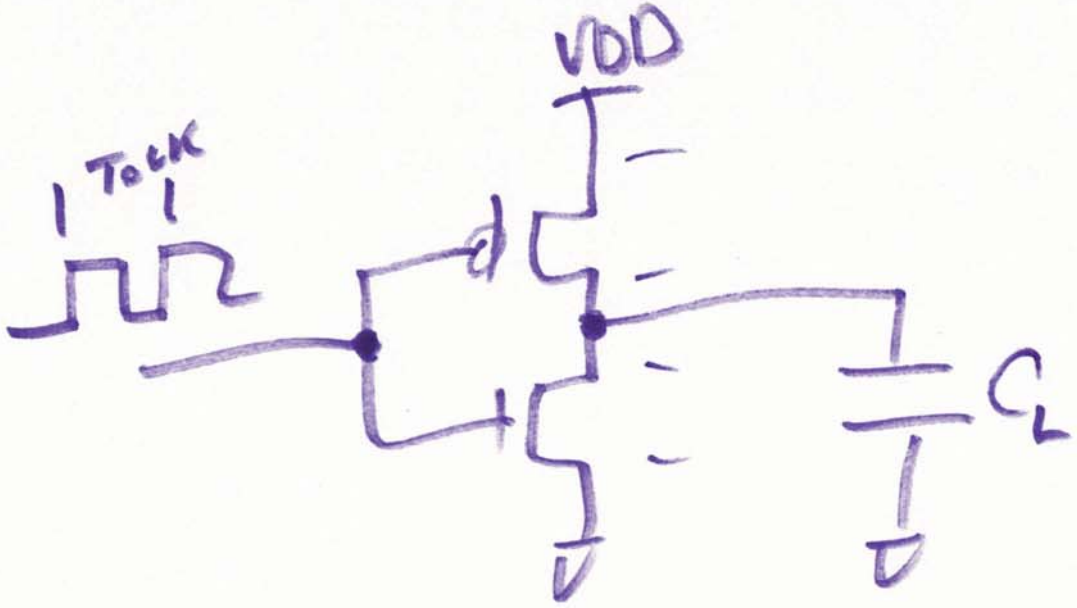
cross-sectional

Logic design - complex cmos logic

dynamic logic

Power dissipated by the inverter

$CV = Q$



$$I_{AVG} = \frac{VDD \cdot C_L}{T_{CLK}}$$

$$P_{AVG} = VDD \cdot I_{AVG}$$

Energy stored

$$\frac{1}{2} C_L VDD^2$$

Contention current

NMOS = PMOS

$$\frac{\frac{1}{2} C_L VDD^2}{T_{CLK}}$$

$$P_{AVG} = \frac{C_L \cdot VDD^2 \cdot}{T_{CLK}}$$