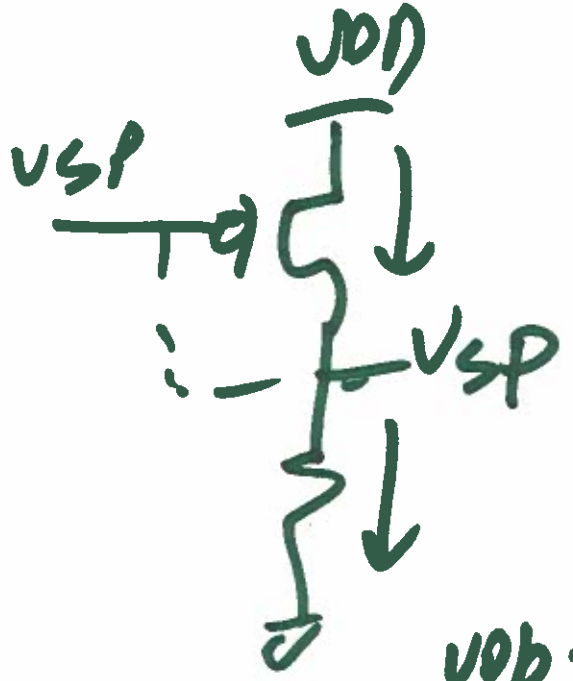
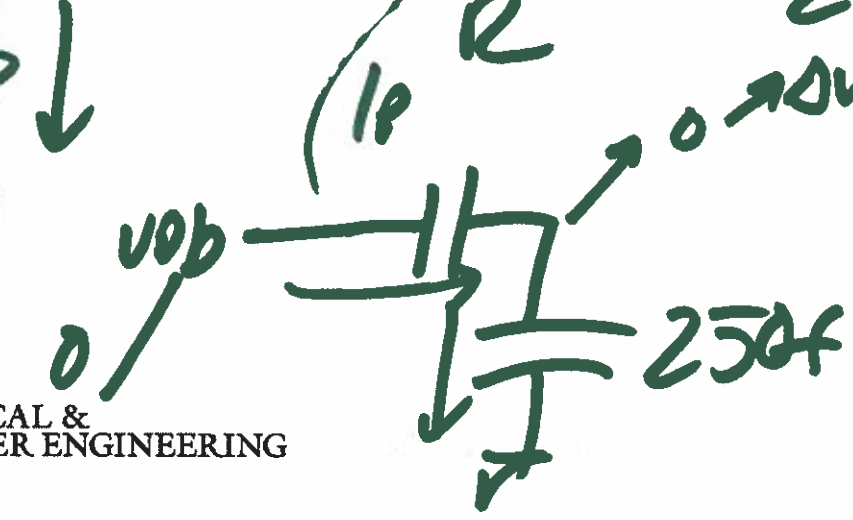
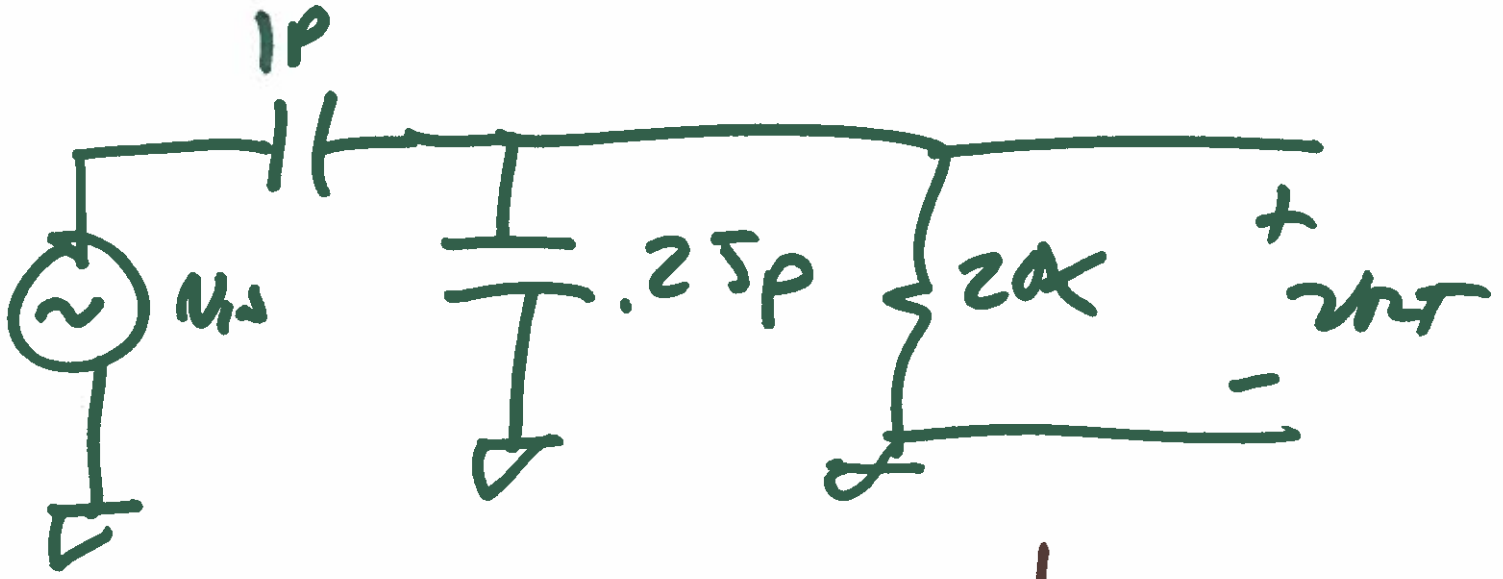
# EE 421 / ECG 621
# Digital IC Design
## Dec. 4, 2019
## Lecture 27




$$\frac{V_{SP}}{R} = \frac{K_{PP}}{2}\frac{W}{L}\left(V_{DD} - V_{SP} - V_{THP}\right)^2$$




$$I_P \cdot (5 - \Delta V_{out}) = \Delta V_{out} \cdot 230fF$$




$$V_{OUT} = V_{IN} \cdot \frac{20K \cdot \frac{1}{j \cdot 2\pi f \cdot 250fF}}{20K + \frac{1}{j 2\pi f \cdot 250fF}}$$

$$\frac{1}{2} = \frac{}{\left(\quad\right) + \frac{1}{j \cdot 2\pi f \cdot 1pF}}$$

$$\frac{20K}{20K \cdot j \cdot 2\pi f \cdot 2.5pF + 1}$$

$$= \frac{20K}{1 + j\,31.4N \cdot f}$$

$$\frac{1}{j \cdot 2\pi f \cdot 1pF} = \frac{j(-15.9G)}{f}$$

$$\frac{V_{OUT}}{V_{IN}} = \frac{1}{2} = \left| \frac{\frac{20K}{1 + j\,31.4Nf}}{\frac{20K}{1 + j\,31.4Nf} + j\left(\frac{-15.9G}{f}\right)} \right|$$

$$\frac{1}{2} = \left| \frac{20k}{20k + j\left(\frac{-15.9G}{f}\right) + 500} \right|$$

$$\left| 20.5k + j\left(\frac{-15.9G}{f}\right) \right| = 40k$$

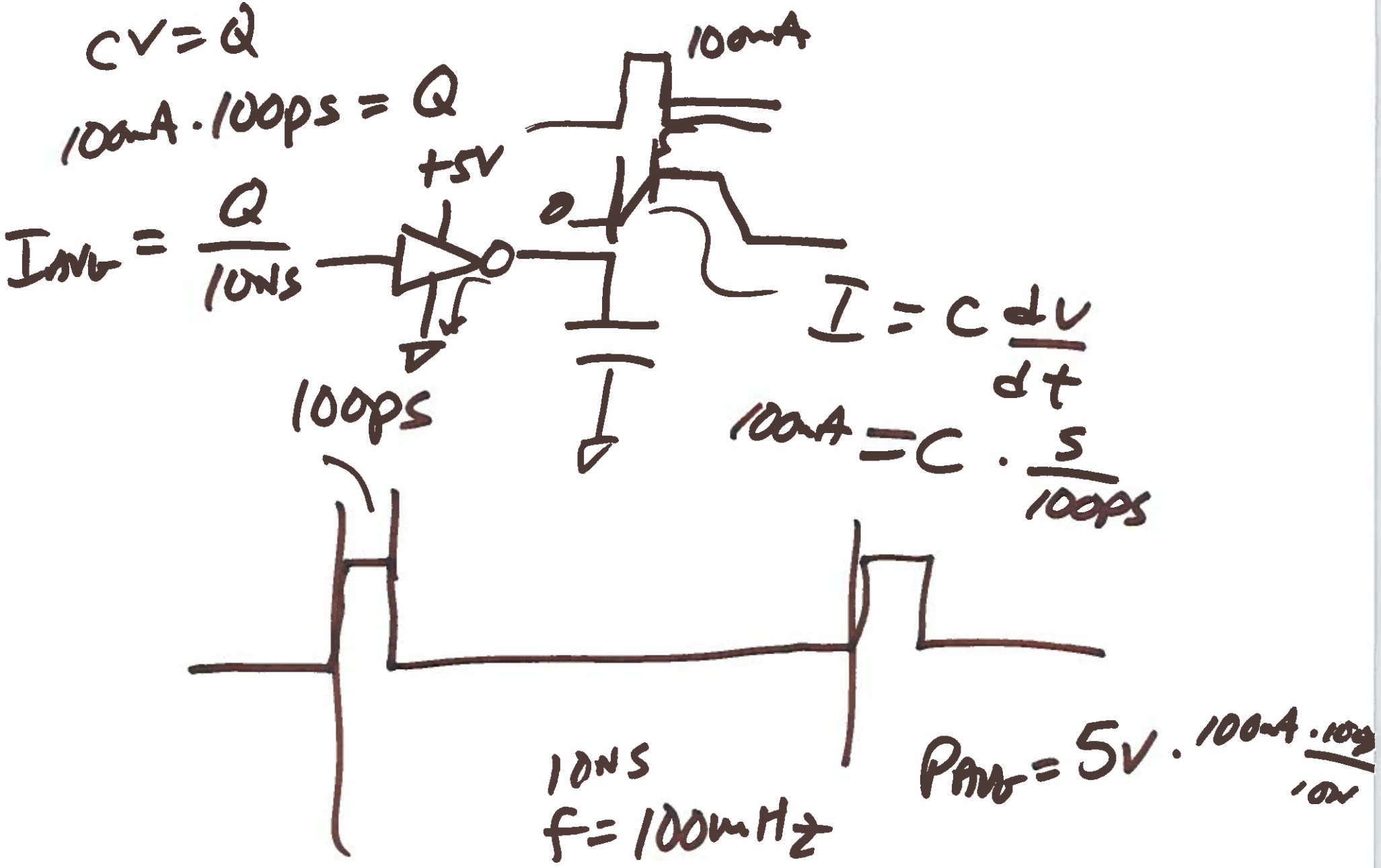
$$\sqrt{(20.5k)^2 + \left(\frac{15.9G}{f}\right)^2} = 40k$$

$$\left(\frac{15.9G}{f}\right)^2 = 3.8$$

$$f = 8.15GHz$$

$CV = Q$

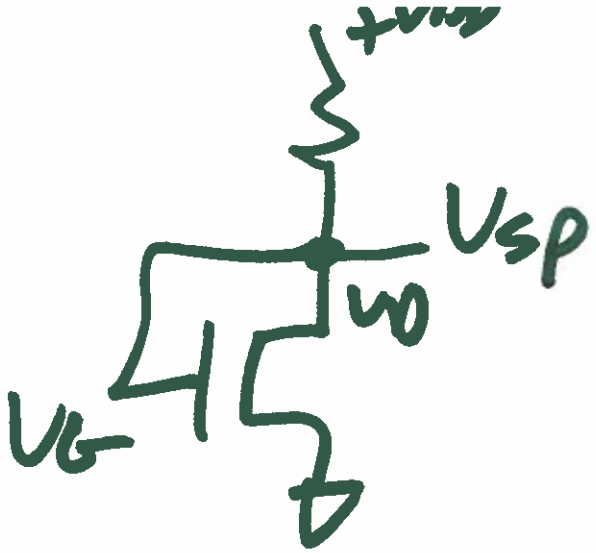
$100mA \cdot 100ps = Q$




$I_{AVG} = \frac{Q}{10NS}$

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

$P_{AVG} = 5V \cdot 100mA \cdot \frac{100p}{10n}$




$V_{GS} \geq V_{THN}$

$V_{DS} \geq V_{GS} - V_{THN}$

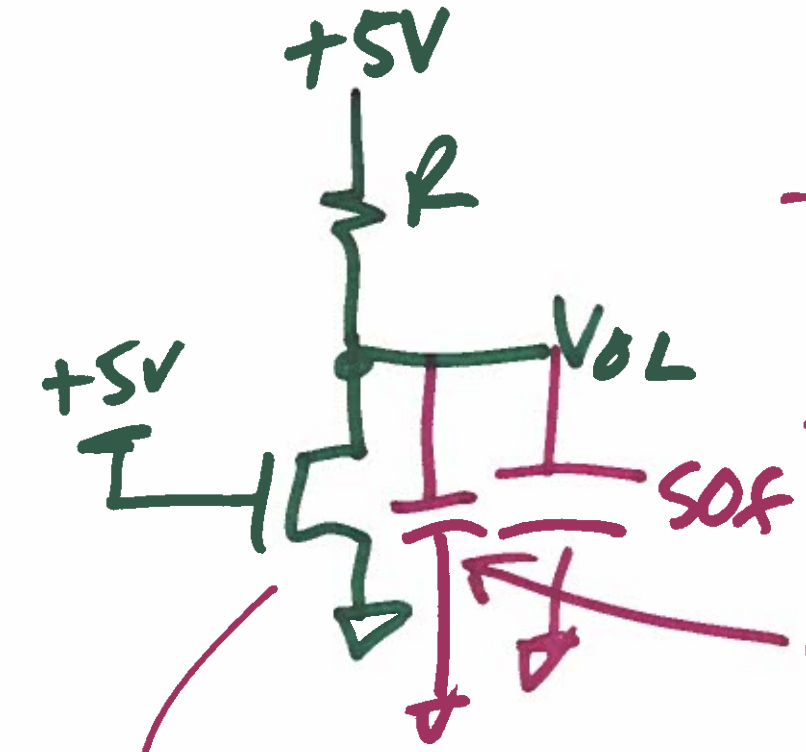
$V_O - V_S \geq V_G - V_S - V_{THN}$

$V_O \geq V_G - V_{THN}$

$0 \geq -V_{THN}$

YES ALWAYS

b)




$t_{pLH} = 0.7R \cdot C_L$

$t_{pHL} = 0.7R_N \cdot C_L$

$W \cdot L \cdot C'_{ox} = 9f$

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

$$\frac{5 - V_{OL}}{R} = \frac{K_{PN} W}{L}\left((V_{DD} - V_{tN}) \cdot V_{OL} - \frac{V_{OL}^2}{2}\right)$$