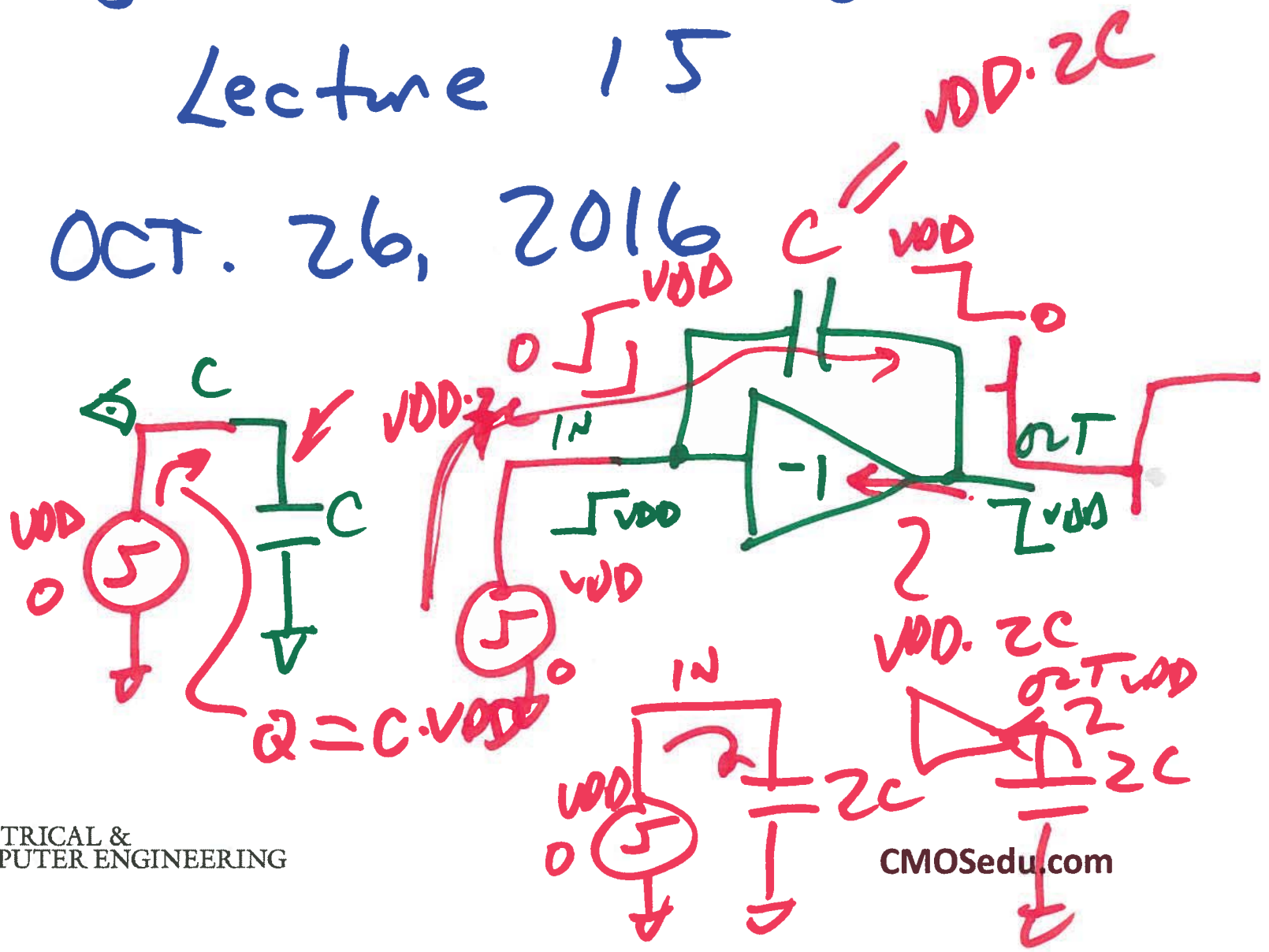
EE 421 / ECG 621

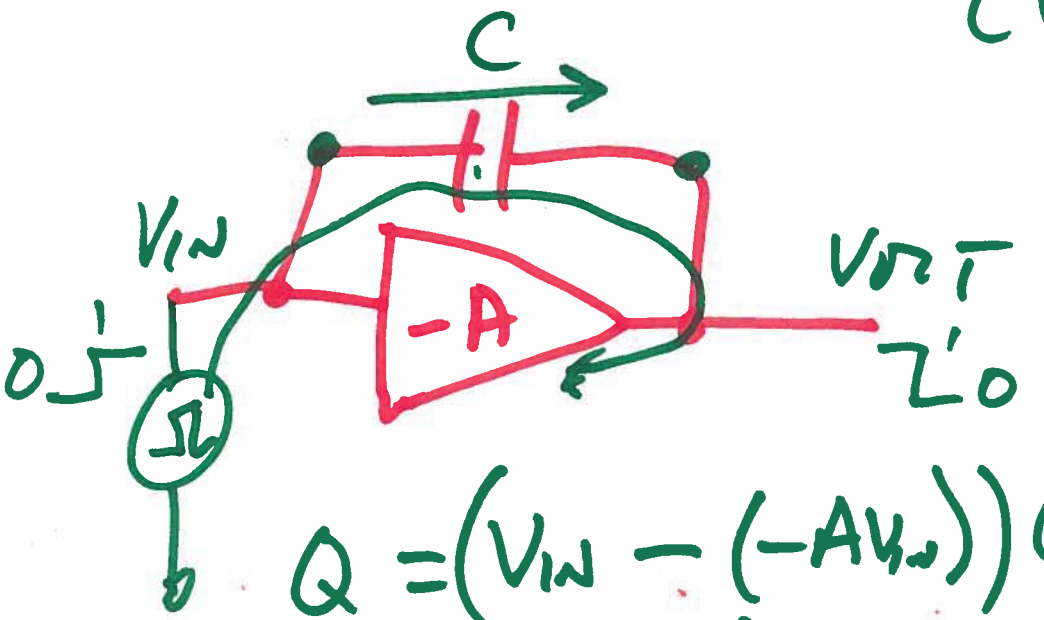
Digital IC Design

Lecture 15

OCT. 26, 2016



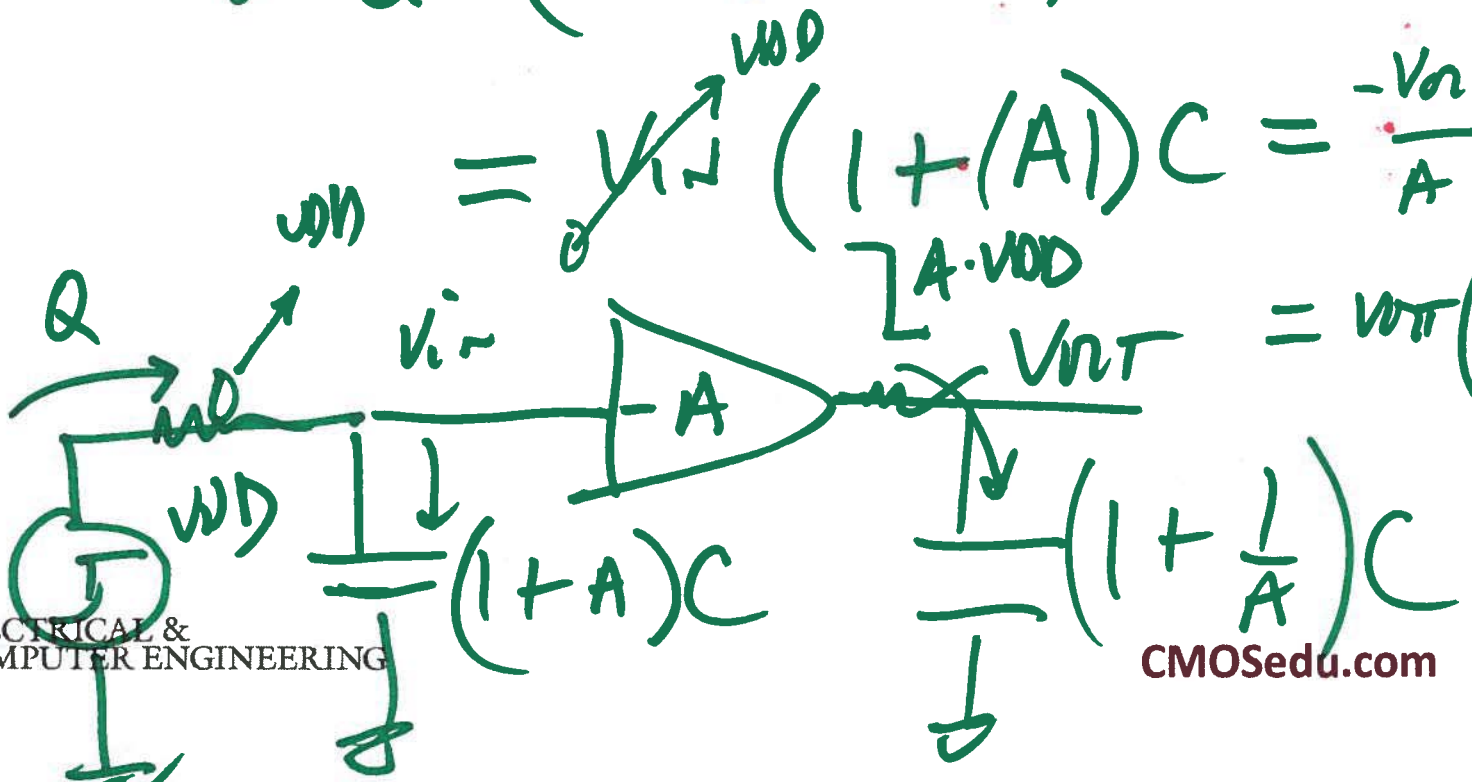
$$CV = Q$$

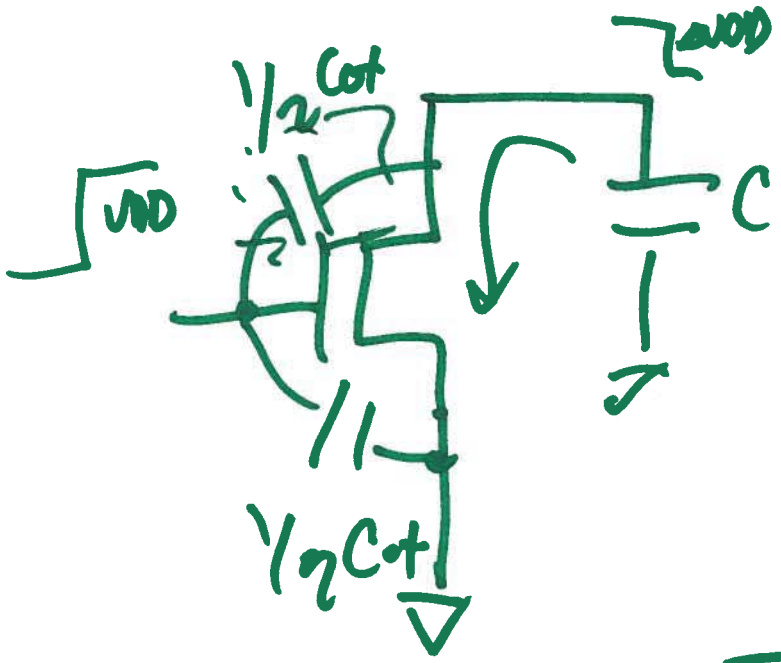


$$Q = (V_{IN} - (-AV_{IN}))C$$

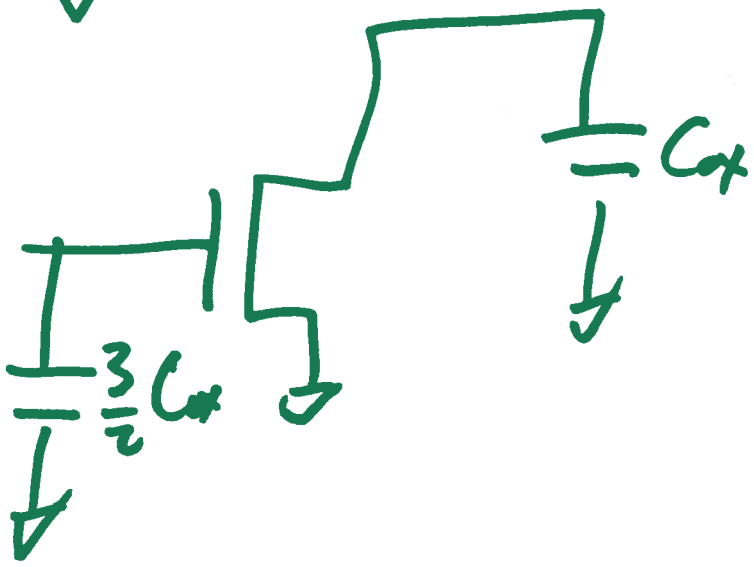
$$= V_{IN}(1 + (A))C = \frac{-V_{OUT}}{A}(1+A)C$$

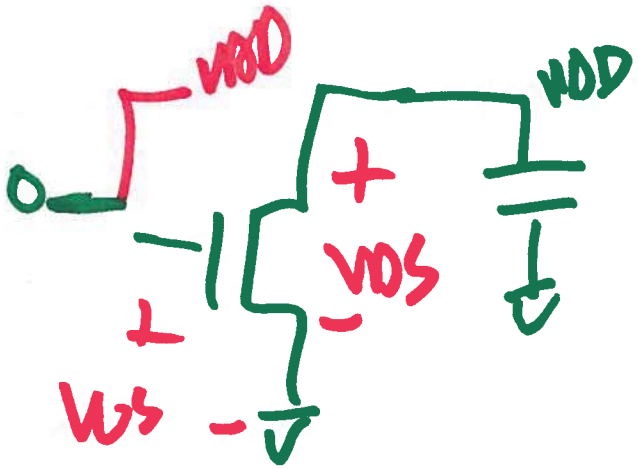
$$= V_{OUT}\left(\frac{1}{A} + 1\right)C$$

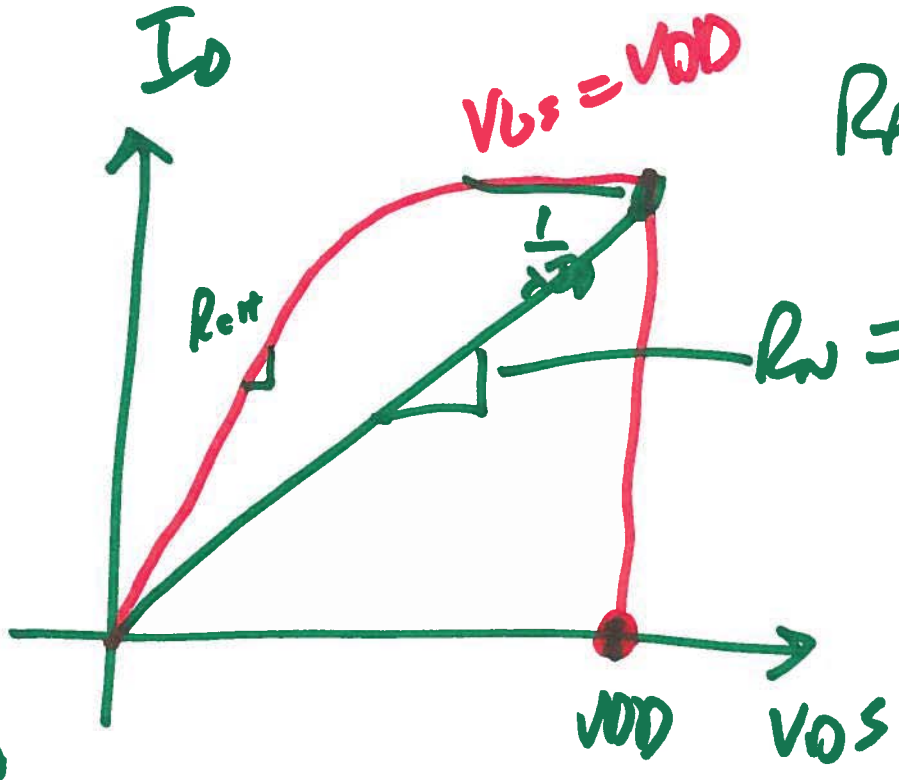




$$C_x = C'_{ox} \cdot W \cdot L$$







$R_P =$

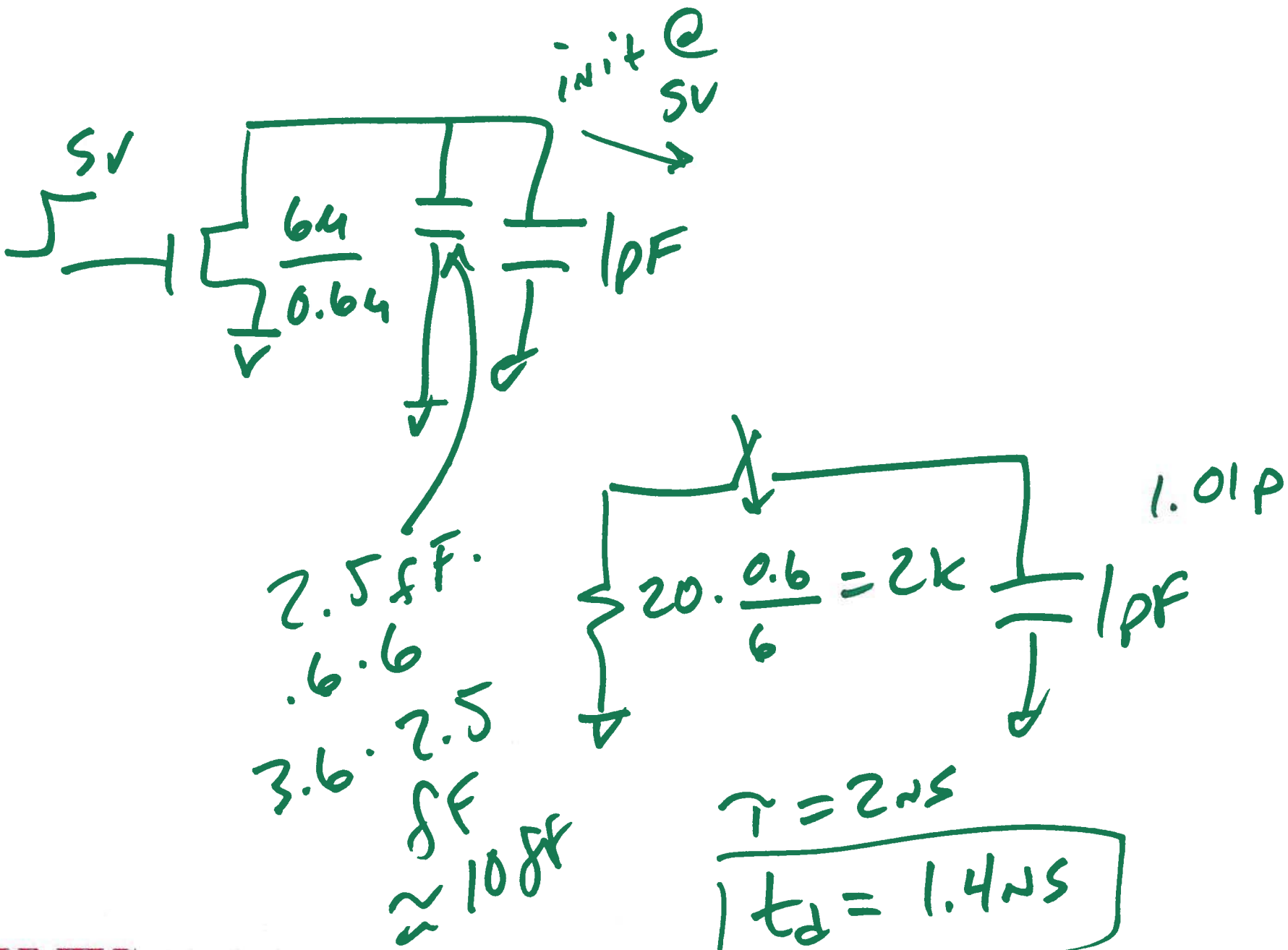
$R_N =$ digital resistance

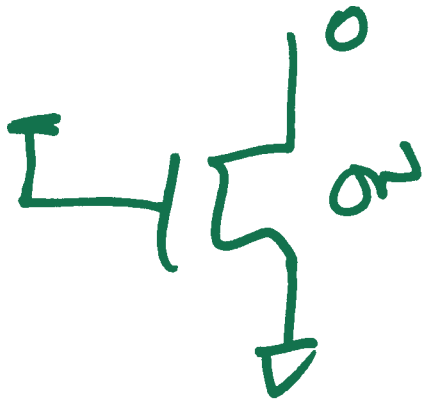
$R_N = R_N' \cdot \frac{0.6}{6} = \frac{5}{2.5mA}$

$R_N' = \frac{50}{2.5mA} = 20k$

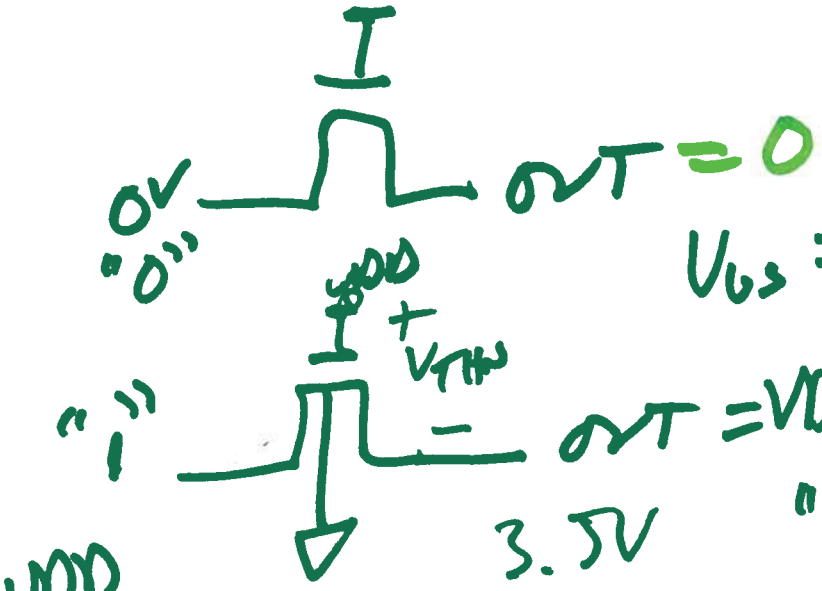
$R_N = \frac{V_{DD}}{I_D} = \frac{V_{DD}}{\frac{K_P}{2} \cdot \frac{W}{L} (V_{DD} - V_{THN})^2}$

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


init @ 5V
5V
64
0.64
1pF
2.5fF
.6.6
3.6.2.5
8F
≈ 10fF
1.01p
20. 0.6/6 = 2k
1pF
τ = 2ns
t_d = 1.4ns

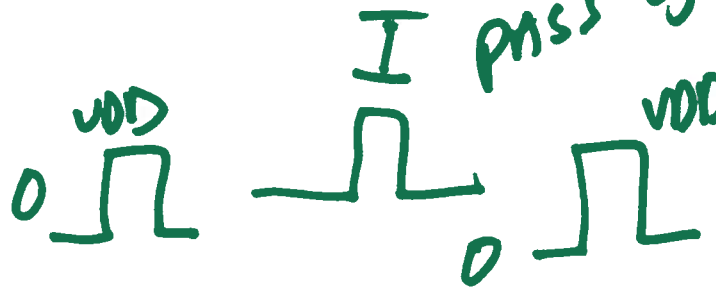


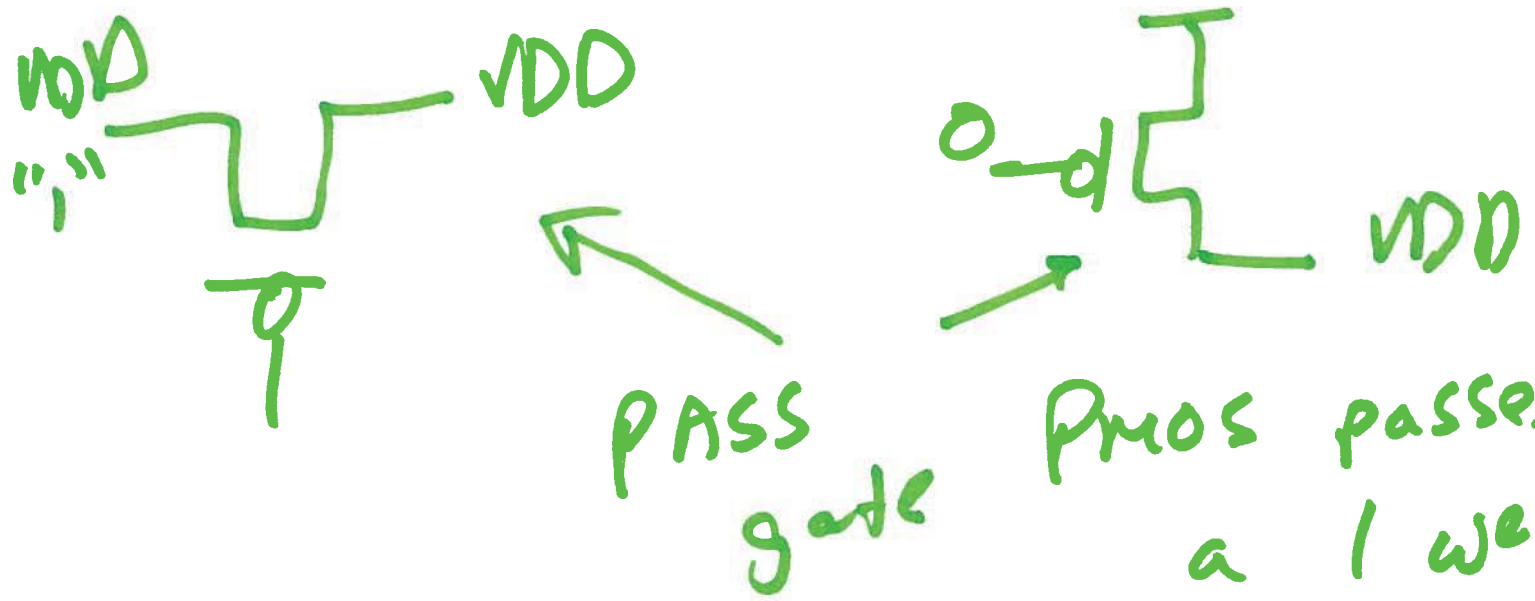
NMOS → passes a 0 well

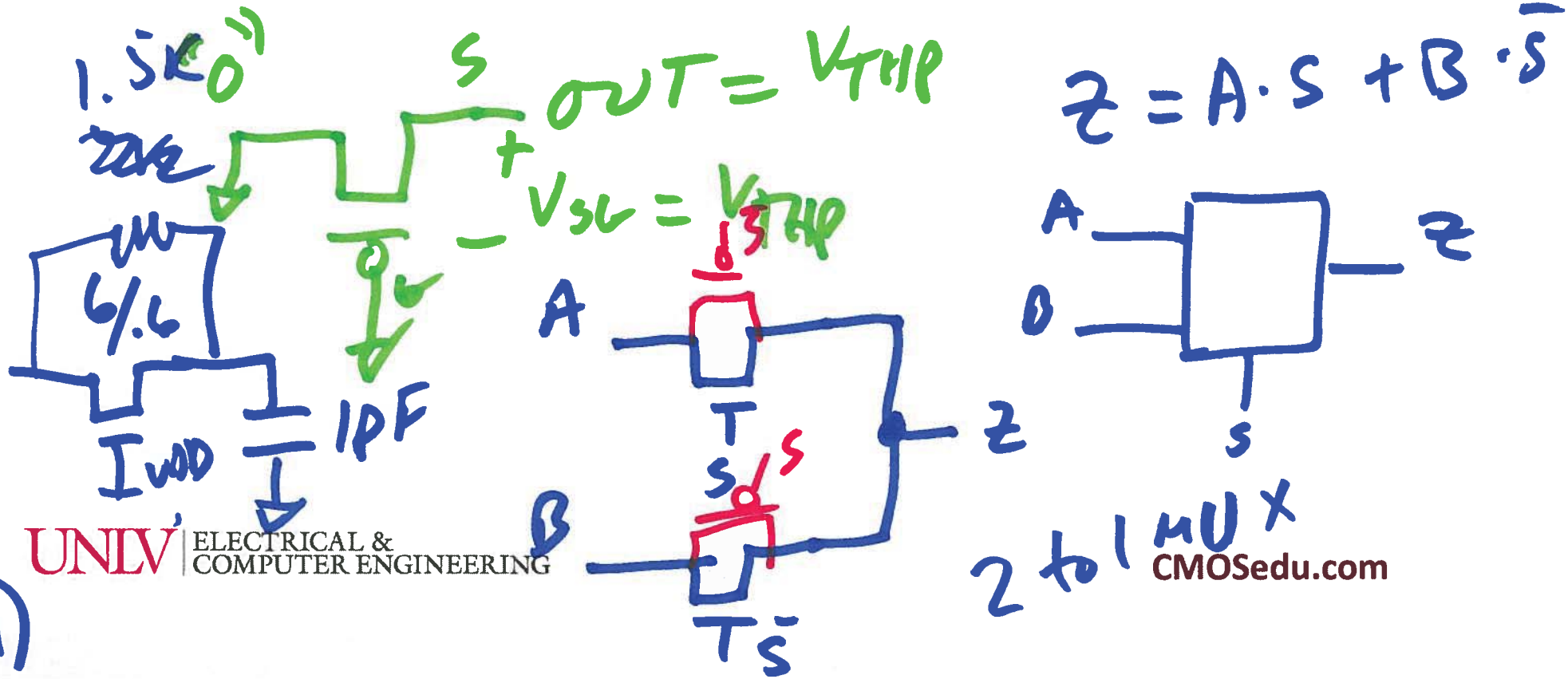


$V_{GS} = V_G - V_S = VDD - (VDD - V_{THN}) = V_{THN}$

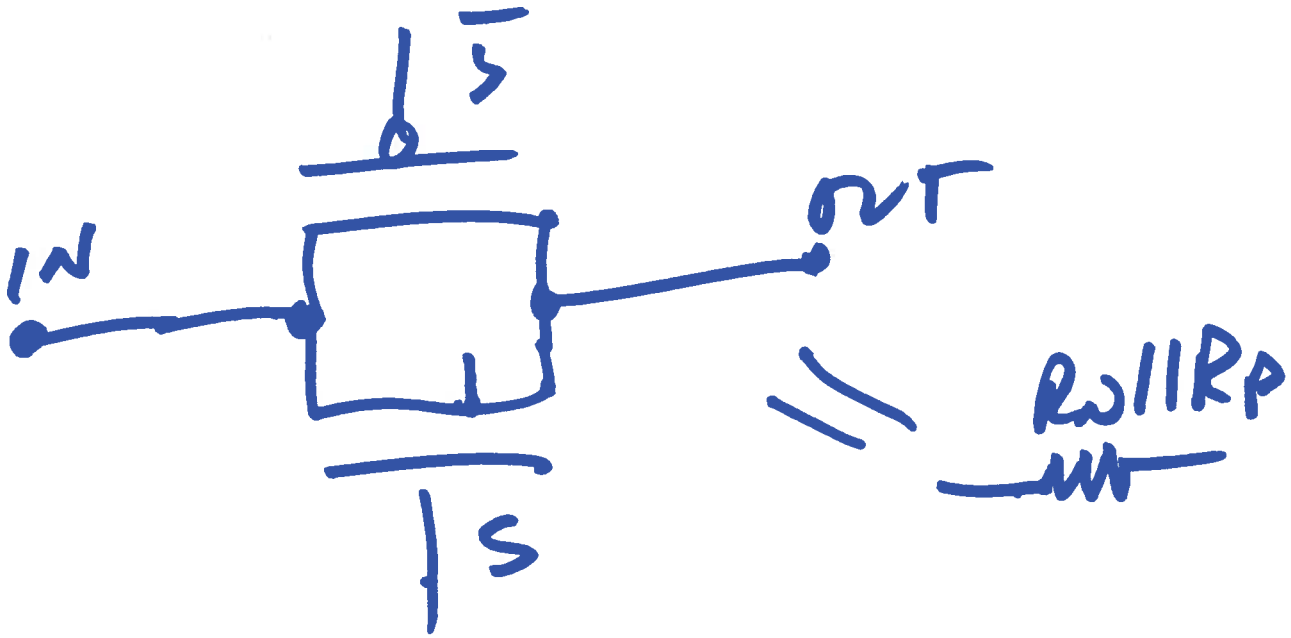
"1" pass gate




VDD
"1"
VDD
0
VDD
PASS gate
PMOS passes a 1 well


1.5K
"0"
S
OUT = VTHP
VSG = VTHP
6/.6
IWDD
1PF
A
B
T
TS
TS̄
Z
Z = A·S + B·S̄
A
B
S
Z
2 to 1 MUX

Transmission Gate (TG)



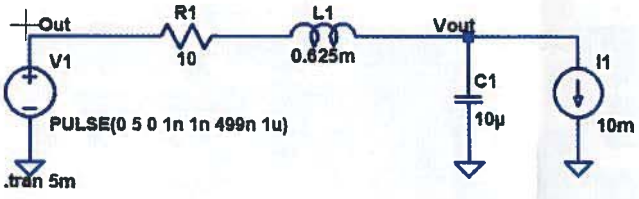
Quiz 8 – EE 421/ECG 621 Digital Electronics and Digital IC Design, Fall 2016

NAME: KEY

Open book and notes.
Show your work for credit!

1. Below is the output filter and associated equations we derived in Lecture 14 for the Buck switching power supply. Assuming the inductor value remains at 625 uH how would the operation of the circuit change if the load current decreases to 1 mA? Increases to 100 mA? (hint: the frequency of the input has to change, change to what? Calculate it.) How does the duty cycle of the input change if the input swings from 0 to 5 and the output is 2.5 V. (5 points)

$D = \frac{1}{2}$



$V_{out} = D \cdot V_{DD}$

$\frac{V_{DD} - V_{out}}{L} = \frac{I_{max} - I_{in}}{DT}$

$\frac{0 - V_{out}}{L} = \frac{I_{max} - I_{in}}{(1-D)T}$

$I_{avg} = \frac{I_{max} + I_{min}}{2}$

for 100mA
Assume → if $I_{max} = 110mA$ & $I_{min} = 90mA$

Then $T = \frac{625\mu \cdot 20mA}{2.5V \cdot \frac{1}{2}} = 10\mu s$, $f = 100kHz$

for 1mA
Assume → if $I_{max} = 1.1mA$ & $I_{min} = 0.9mA$

Then $T = \frac{625\mu \cdot 0.2mA}{2.5V \cdot \frac{1}{2}} = 100ns$

$f = 10MHz$

Duty cycle doesn't change. Stays $\frac{1}{2}$