# EE 421/ECG 621

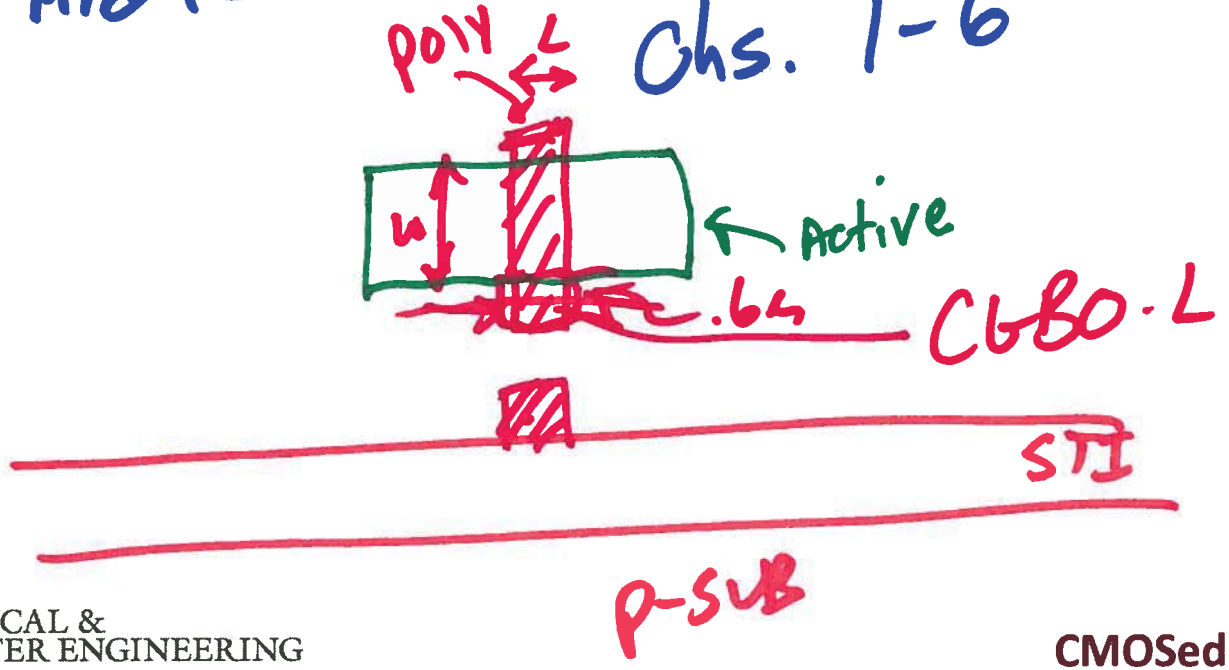
## Lecture 13

## OCT. 12, 2016

## Digital IC Design

Midterm ON Monday

Chs. 1-6



$$Q_I'(y) = C_{ox}'\left(V_{GS} - V(y) - V_{THN}\right)$$

$V_{DS} = V_{GS} - V_{THN}$ $\quad Q_I'(y) = 0$


$V_{DS,SAT} = V_{GS} - V_{THN}$

$V(0)$ $\quad V(L) = V_{DS}$

$\geq 0$

Quizzes
H.W. problems (additional) → Also look the ones not assigned
End chapter problems

Chs. 1-6

Basic layout
- pTMP / nTMP — p-select, p-active
- CC
- Metal 1

Unit cells

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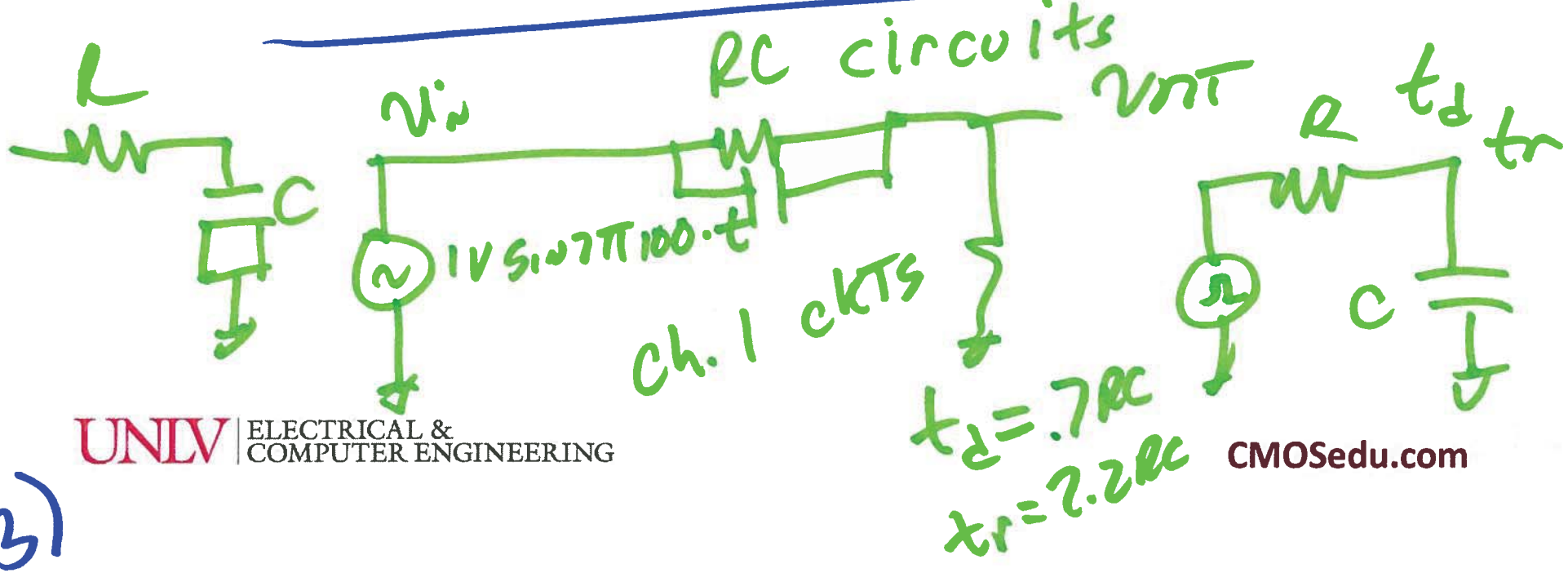
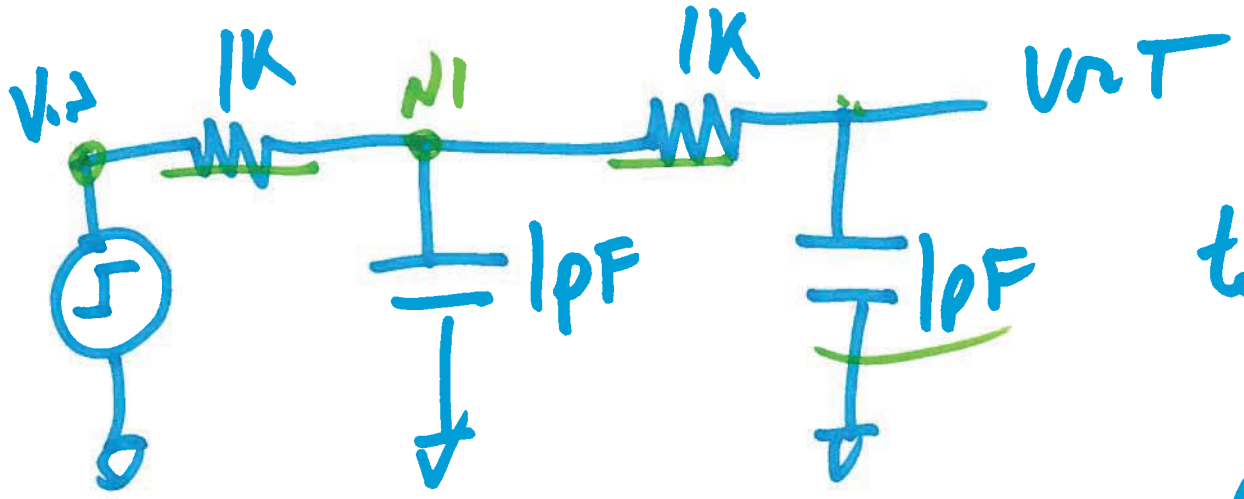
RC circuits



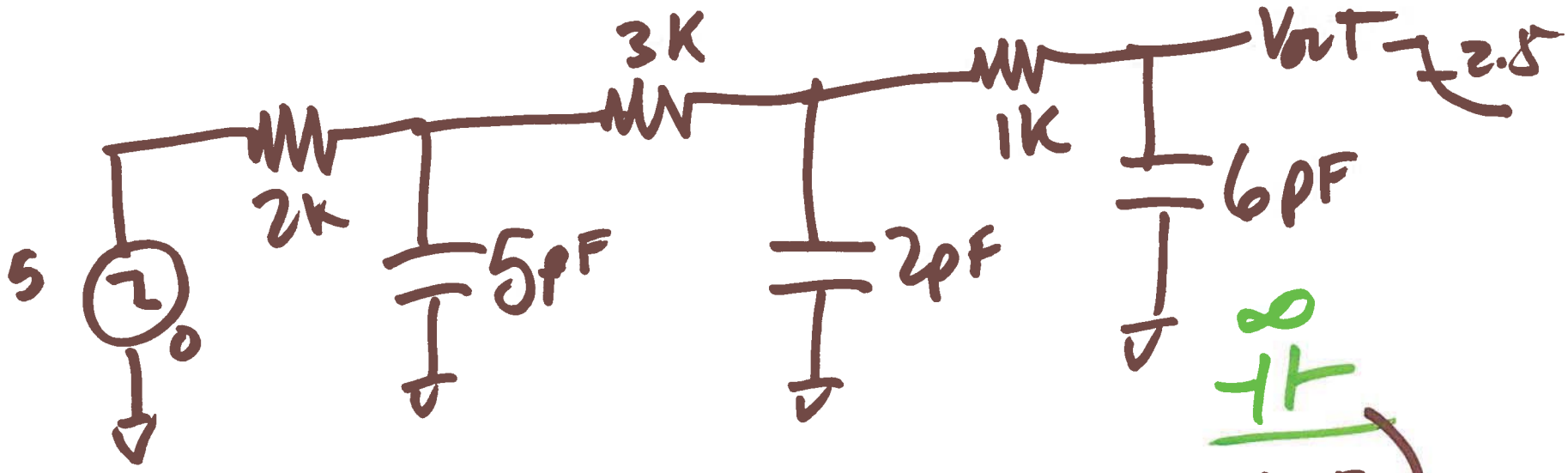



$t_d = 0.35\,1K \cdot 1pF \cdot 2^2$

$0.35\,rce^2$

$$t_d = \underbrace{0.7 \cdot 1k \cdot 1pF}_{V_{IN} \to N1} + \underbrace{0.7 \cdot (1K + 1K) \cdot 1pF}_{V_{IN} \to Output}$$

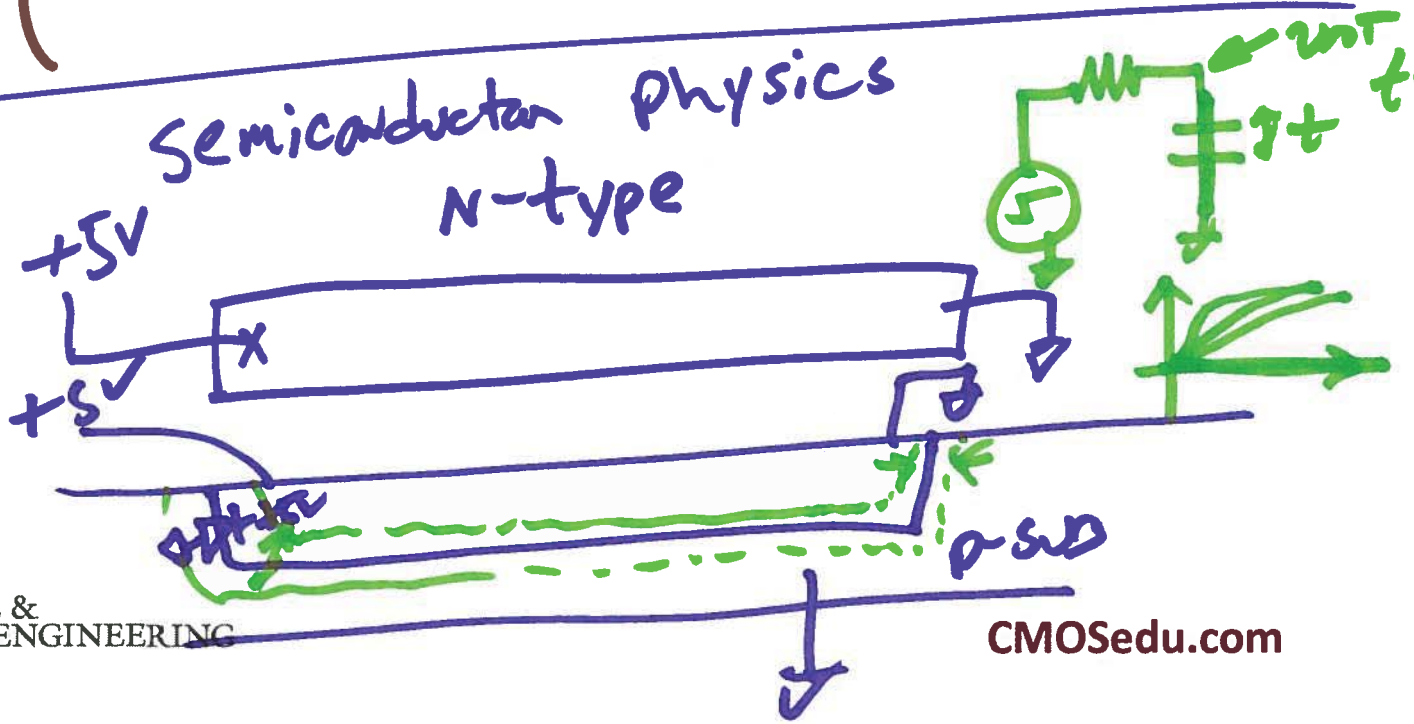
$$= 0.7\,1pF\,(3K)$$




$$t_d = 0.7\left(2k\cdot 5pF + 5k\cdot 2pF + 6k\cdot 6pF\right)$$

Semiconductor physics
N-type

$\frac{\epsilon A}{t}$ $t \geq 0$ $C \to \infty$

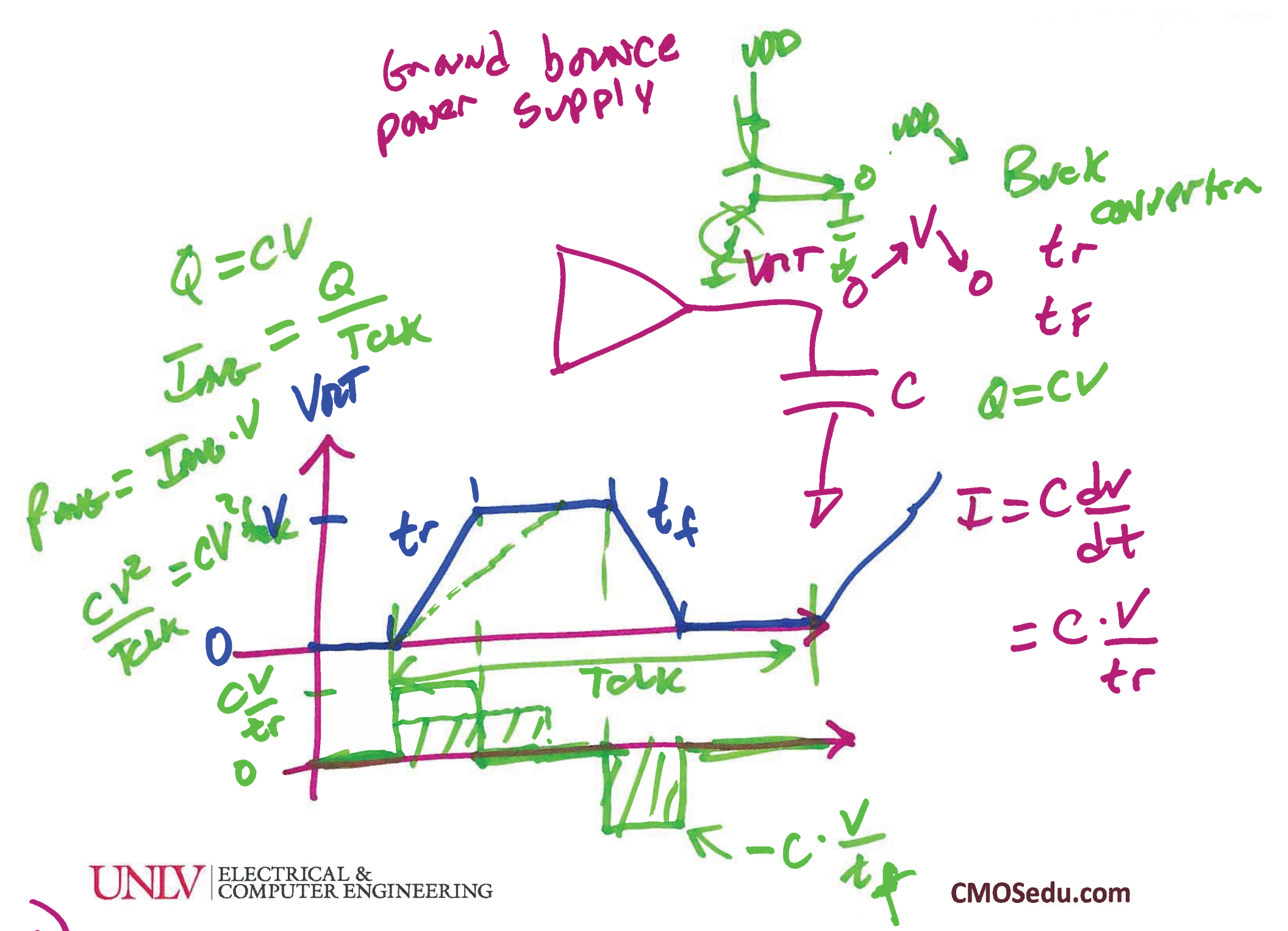


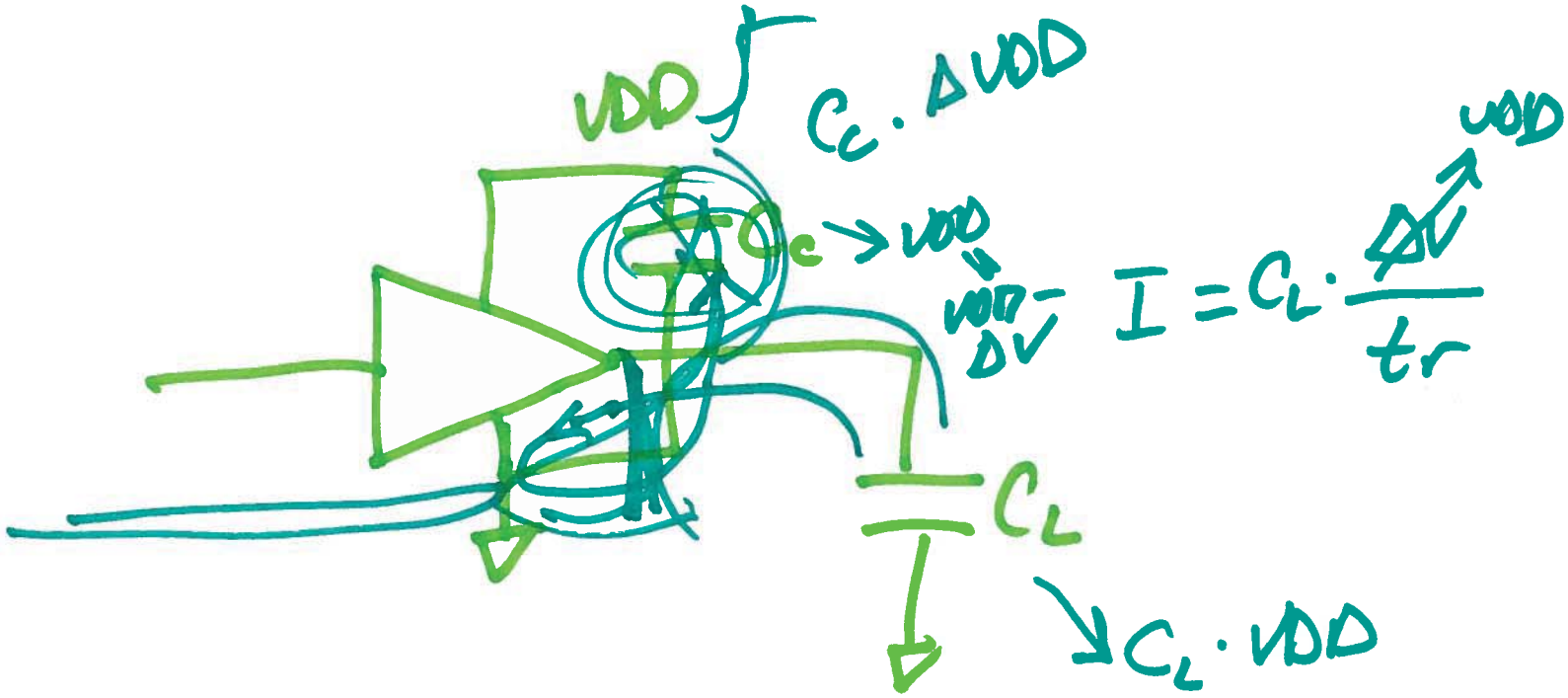
diode reverse recovery

Sheet resistance
- n-well
- poly
- N+
- metal 1

1,000 μm Long piece of metal 1
0.9μ wide. the sheet $R = 0.15\Omega/\square$
suppose it's loaded every 1μm with
a 1pF cap what is the delay through
the metal line?

Calculate R values


Ground bounce
power supply
VDD
VDD
0
Buck
converter
VOUT
V
0
tr
tF
C
Q=CV
Q=CV
$I_{AVG} = \frac{Q}{T_{CLK}}$
$P_{AVG} = I_{AVG} \cdot V$
VOUT
$\frac{CV^2}{T_{CLK}} = CV^2 f_{CLK}$
V
tr
tf
0
$I = C\frac{dV}{dt}$
$= C \cdot \frac{V}{tr}$
$\frac{CV}{tr}$
0
TCLK
$-C \cdot \frac{V}{tf}$




$$C_c \cdot \Delta VDD = C_L \cdot VDD$$

$$\Delta VDD = \frac{C_L \cdot VDD}{C_c}$$

$$C_c = \frac{C_L \cdot VDD}{\Delta VDD}$$