EE 421 / ECG 621
Digital IC Design

Oct. 18, 2013

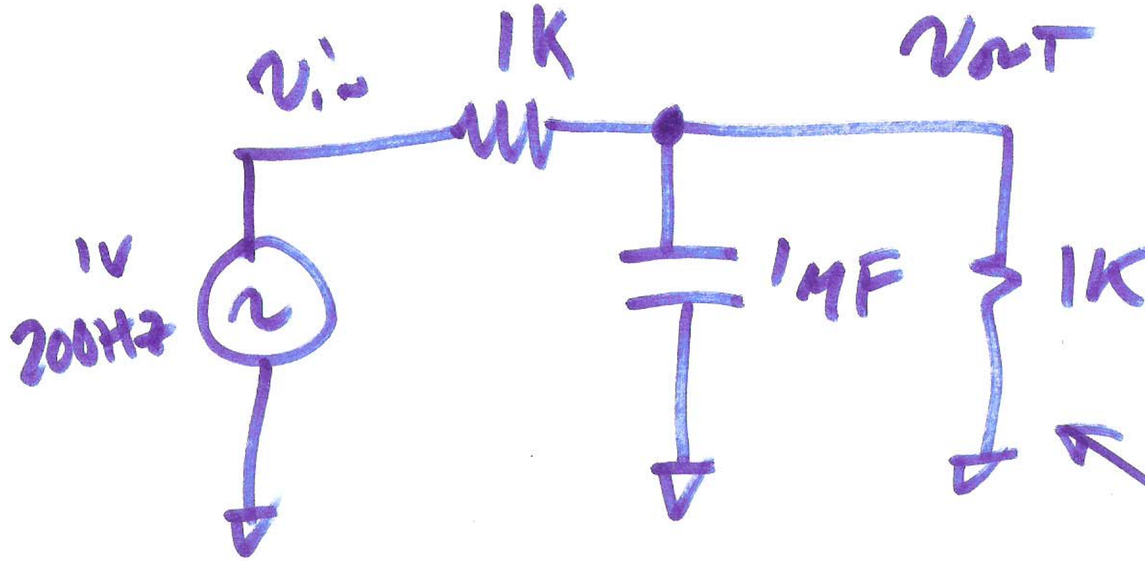
Lecture 16

Review for midterm

Chs. 1-6

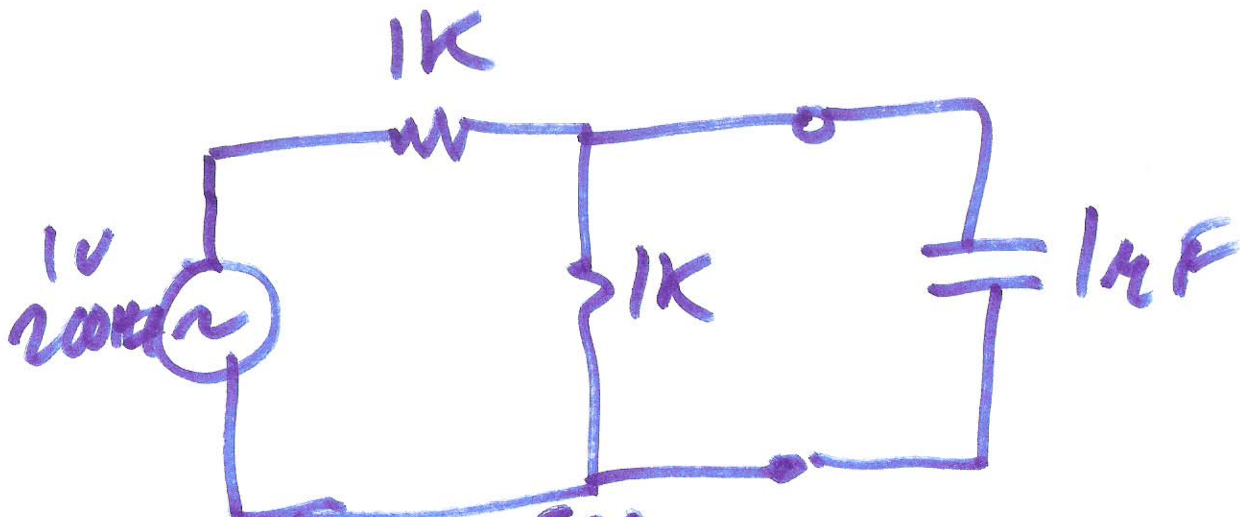
H.W. problems assigned and end of chapter

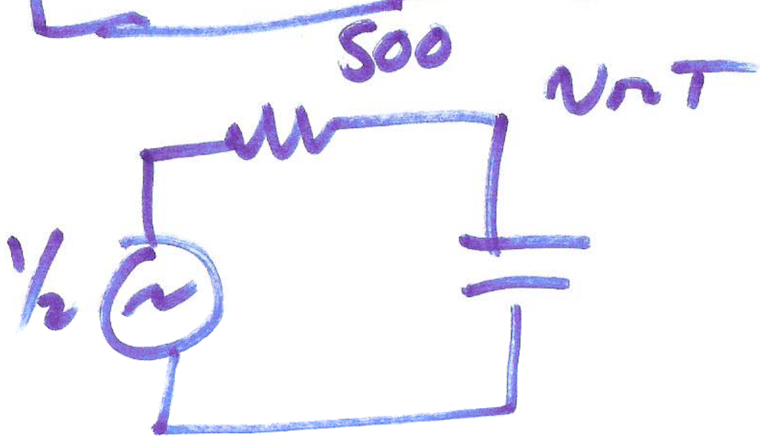
Quizzes



Sketch V_{OUT} & V_{in} on same plot

$$Z = \frac{1K \cdot \frac{1}{j\omega 10^{-6}}}{1K + \frac{1}{j\omega 10^{-6}}} = \frac{10^3}{1 + j\omega 10^{-3}}$$





$$V_{OUT} = v_{in} \cdot \frac{\frac{\cancel{10^3}}{1 + j\omega 10^{-3}}}{\cancel{10^3} + \frac{\cancel{10^3}}{1 + j\omega 10^{-3}}}$$

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2)

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$$\frac{v_{OUT}}{v_{IN}} = \frac{1 + j0}{2 + j\omega 10^{-3}}$$

$$\left|\frac{v_{OUT}}{v_{IN}}\right| = \frac{\sqrt{1^2 + 0^2}}{\sqrt{2^2 + (2\pi f 10^{-3})^2}} \rightarrow \frac{1}{\sqrt{4 + (2\pi f \cdot 10^{-3})^2}} = \frac{1}{2} \frac{1}{\sqrt{1 + \left(\frac{2\pi f \cdot 10^{-3}}{2}\right)^2}}$$

$$\angle\frac{v_{OUT}}{v_{IN}} = \tan^{-1}\frac{0}{1} - \tan^{-1}\frac{2\pi f \cdot 10^{-3}}{2}$$

$$4 = \left(2\pi f_{3dB} \cdot 10^{-3}\right)^2$$

$$\cancel{2} = \cancel{2}\pi f_{3dB} \cdot 10^{-3}$$

$$f_{3dB} = \frac{1\,KHz}{\pi} = 159\,Hz$$

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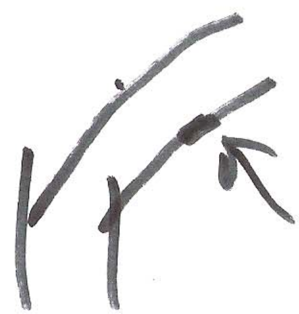
3)

$$\left|\frac{v_{out}}{v_{in}}\right| = \frac{1}{\sqrt{2^2 + (2\pi \cdot 200 \cdot 10^{-3})^2}}$$

$$\angle \tan^{-1} = -\tan^{-1} \pi \cdot 200 \cdot 10^{-3}$$

$$= -\tan^{-1} .2 \cdot \pi$$



lagging

$$\frac{\Delta t}{T} \cdot 2\pi = \tan^{-1} .2\pi$$

N-Well → Resistor
diode with the p-sub
Body of PMOS

RC delay of a transmission line

derive $0.35rcl^2$

depletion C — bottom / sidewall cap

reverse recovery time

Laying resistors in small areas

design rules

what sets n-well spacing

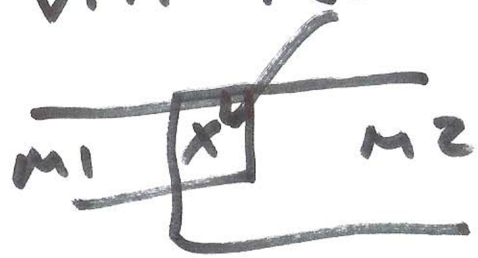
Energy band diagrams

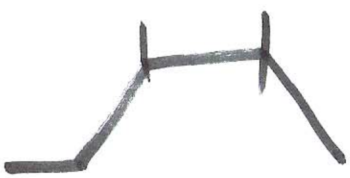
Suppose you forward bias a diode

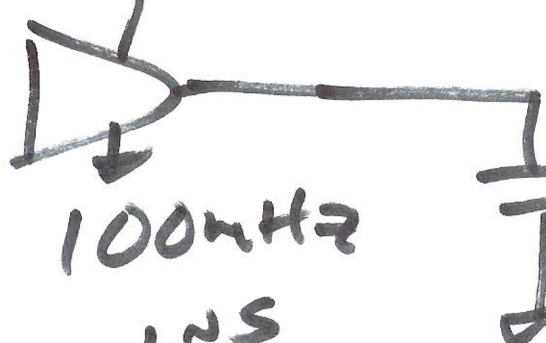
Sketch Energy band

Metal layers

Layouts
- electromigration
- resistance of the line
- parasitic cap.
- via resistance





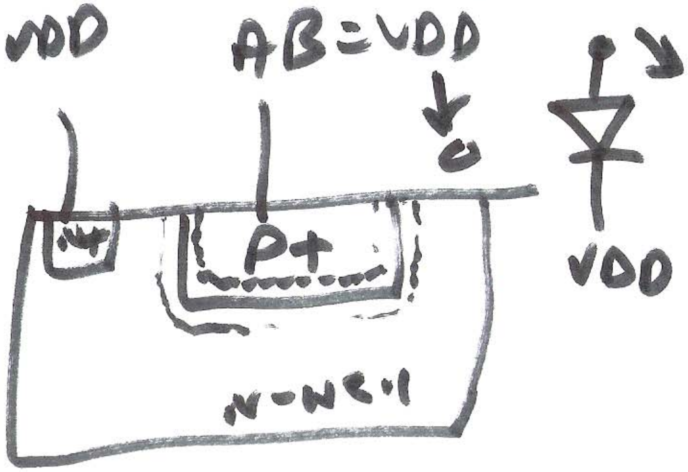


Estimate Ipeak

AVG. power

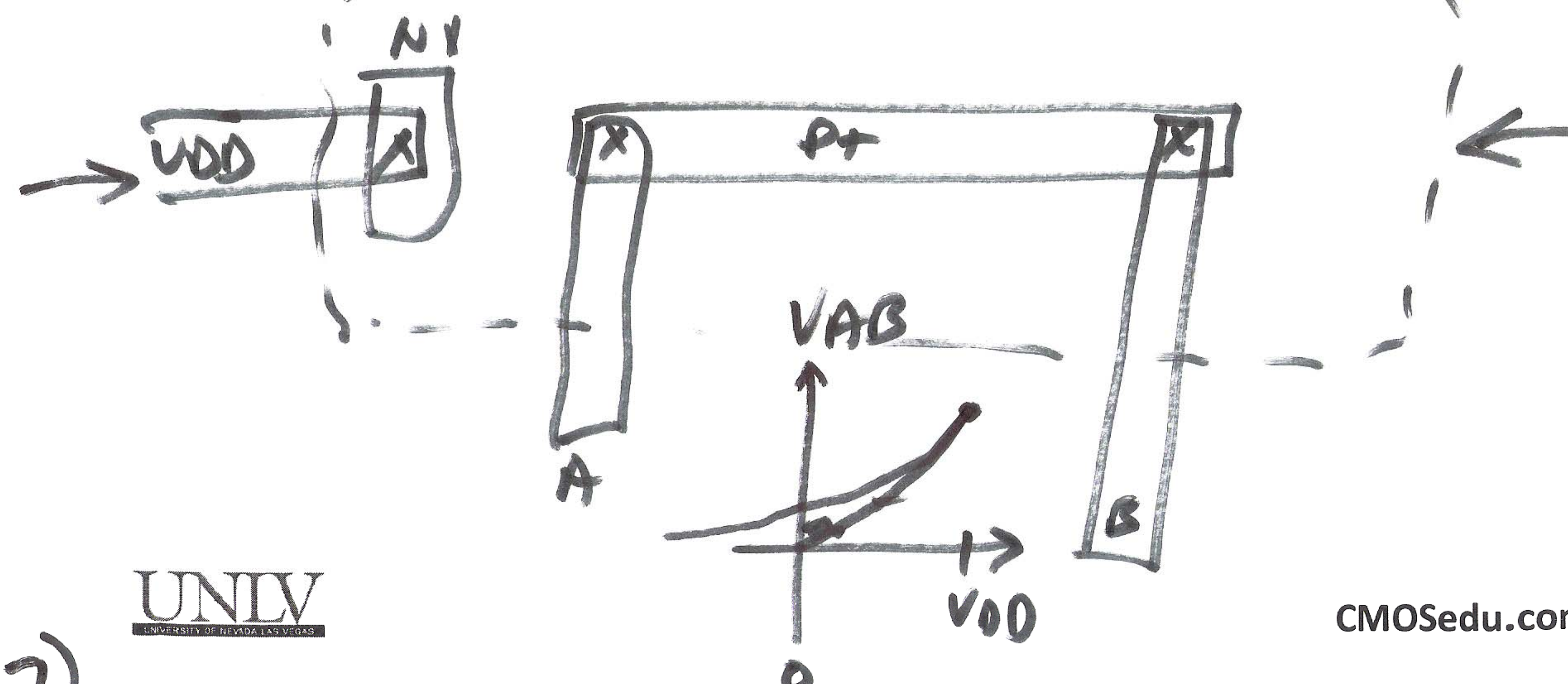
$$I = C\frac{dv}{dt} = \frac{5}{1ns}\cdot 10pF$$

Ch. 4



ACTIVE AREA
PN junctions
Layouts
estimate R

$R_{D,p+} = \frac{50\Omega}{\square}$



polysilicon

describe what polysilicon is

used to form a MOSFET

self-aligned gate

silicide

MAKE with poly

poly1 - poly2

drawn width

length → Ldrawn

Leff

Lelec

DIBL → Lelec

CLM

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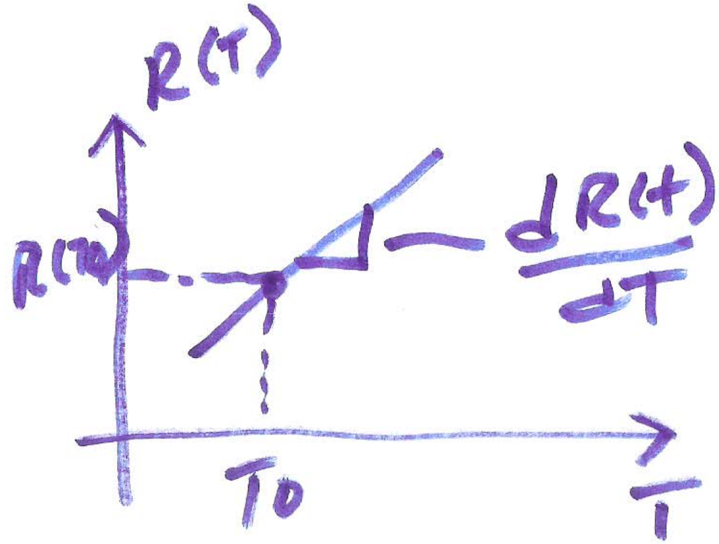
Resistor temp co.



$$R(T) = R(T_0) + \frac{dR(T)}{dT}(T - T_0)$$

$$= R(T_0)\cdot\Big(1 + \underbrace{\frac{1}{R(T_0)}\frac{\delta R(T)}{\delta T}}_{TCR}(T - T_0)\Big)$$

using unit elements
why?
How?
when?

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MOSFETS

IV curves

Regions of operation

Strong, weak, Accumulat.

Oxide CAP.

MOSFET CAPS.

Threshold voltage derivation

body effect

Contact potentials

Threshold adjust

etc.

Subthreshold current

velocity saturation

Know how to derive Q_b', Q_I', Q_{CH}'

square-law equations

C_{gs} derivation in saturation

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