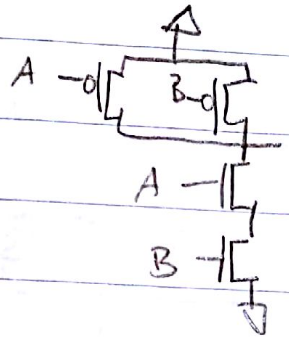
Dis 5

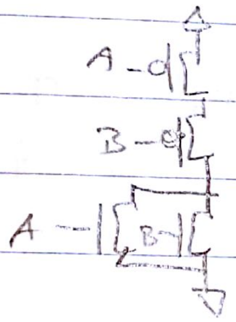
Worksheet:

2) a.

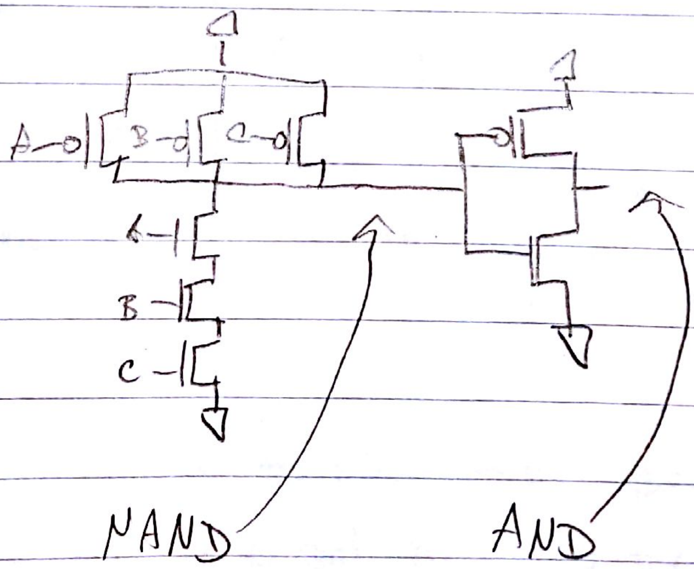


A	B	Nand	NOR
0	0	1	1
0	1	1	0
1	0	1	0
1	1	0	0

b.



3)



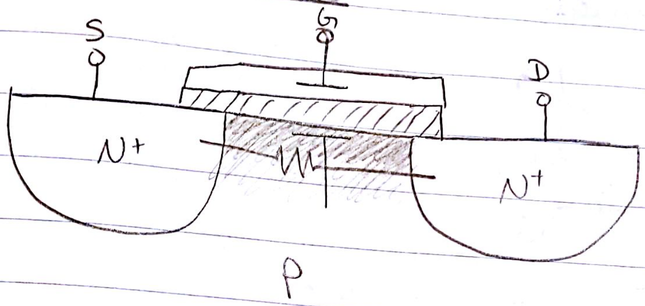
4) $\overline{AB + \bar{A}\bar{B}}$

5) $\overline{(A+B)\cdot C}$

6)

B_0	B_1	B_2	$\overline{B_0 B_1 B_2}$	$\bar{B}_0 + \bar{B}_1 + \bar{B}_2$
0	0	0	1	1
0	0	1	1	1
0	1	0	1	1
0	1	1	1	1
1	0	0	1	1
1	0	1	1	1
1	1	0	1	1
1	1	1	0	0

MOSFET Review



What is this structure?

MOSFET (what does that stand for
Metal oxide semiconductor field effect device)

Lets talk about each terminal:

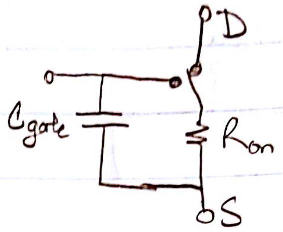
Gate:

- Oxide isolates the gate from drain or source
- Metal acts like a big capacitor

Source/Drain:

- 'Source' of carriers (electrons for nmos, opposite for pmos)
- Source & Drain are connected by a resistor

Switch model:



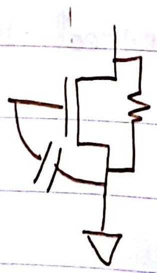
Why do we even care about those C & R?

Delay - the bigger C or R the more delay

There are two places we care about C & R.
Input & Output

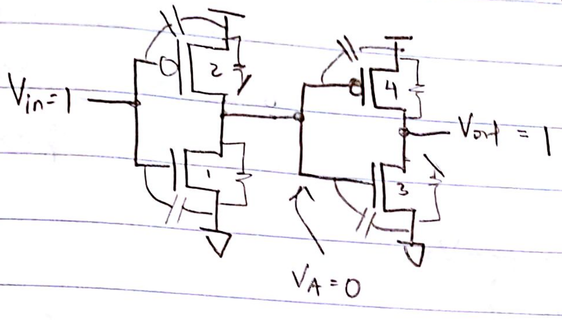
You will learn the particulars of how to calculate delay in lecture, so lets practice collecting all the Rs & Cs together to make the math easier

Lets redraw our mosfet



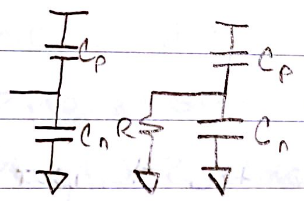
Now, it is easy to see that we care about Capacitance on the input & resistance on the output

In class you looked at two inverters



So, 1 & 4 are on so they have a resistance
2 & 3 are off so they don't

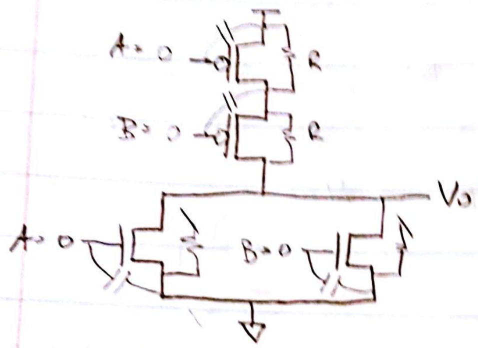
We rewrite as



What capacitance on the input? $C_p + C_n$

What resistance on the output? R
capacitance ? $C_p + C_n$

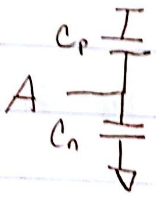
Now, lets do a harder one, NAND



What is the resistance on the output?

$\Rightarrow 2R_p$

What is the capacitance on the A input?



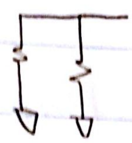
$\Rightarrow 2C$

Now let A = 1 & B = 0 then B = 1. Find the output resistance yourself.

A = 1
B = 0

R_n

A = 1
B = 1



$R_n || R_n = \frac{R}{2}$

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SVD

The all impt. SVD eqn

$$M = U \Sigma V^T$$

where

M is a matrix that represents something impt & complex to you

V are orthogonal vectors which are eigenvectors of M ($M v_i = \lambda v_i$)

In other words, V is a current domain

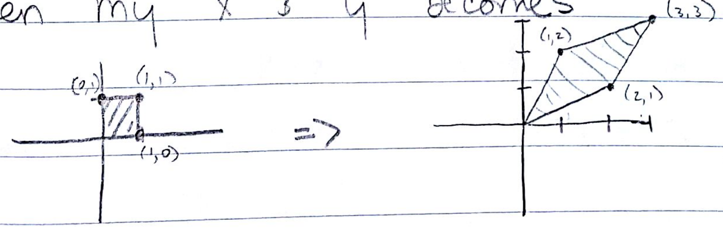
U are orthogonal vectors of a co-domain

Σ are weights that describe M in the co-domain

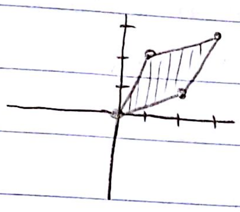
For example, if I am given some M transform

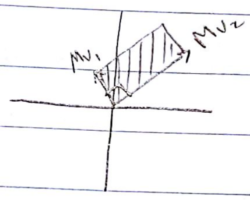
$$M = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

Then my x & y becomes

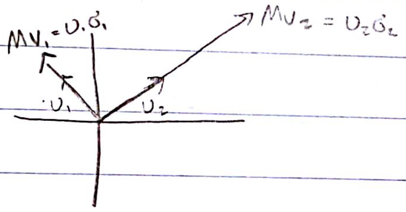


I can describe this transformation in parts, first break M into eigen values so that I can describe the transform in an orthogonal domain





Next, turn those eigen vectors into unit vectors & weights



where U is the new co-domain of u_i vectors & σ_i are the weights that translate $Mv_i = u_i\sigma_i$

Thus, we can kind of intuit what it means to break M into 3 parts

$$M = U \Sigma V^T$$

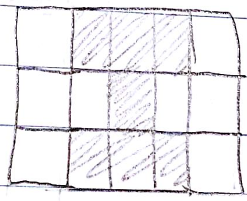
Now, why is this useful? What are the applications of this?

How did we use it in lab?

Noise reduction

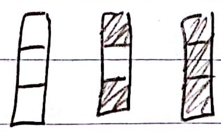
- we can look at the weight (σ_i) of each u_i vector & determine what u_i are very impt in M & which don't change very much, then we keep some number of the largest σ_i.

Example:



Imagine we describe this picture as a 1 for a black box & 0 for white

We can see very easily that there are only 3 vectors in this picture



When we break M into parts we will get back only $\sigma_1, \sigma_2, \sigma_3$ for each of the three independent vectors, & 3 u_i vectors

SVD has given us a way to transform into the three most important vectors.

This is what you did in lab, but with some noise mixed in, you got back a lot of vectors, but by only taking the 20 largest σ_i, you picked out the more "important" vectors that could describe the neuron data.

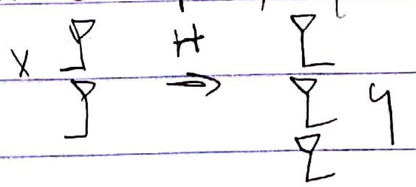
What are other applications?

- Netflix recommendations
- Image compression
- Machine learning

Lets look at the SVD problem in your HW.

Another application of SVD is to rewrite a transform into matricies with nicer properties

for example, you are given



What is a formula (w/o SVD) to describe this?

$$y = Hx$$

we can break H into SVD, what is it?

$$H = U \Sigma V^T$$

$$y = U \Sigma V^T x$$

orthogonal matrix diagonal

Now we have an equation in terms of only unitary & a diagonal matrix