

CS/ECE 252

Exam 4 Review

11AM section
2015 December 11



Before we get started

Homework 8 due at beginning of lecture

Exam 4 on Monday, December 14th, during class

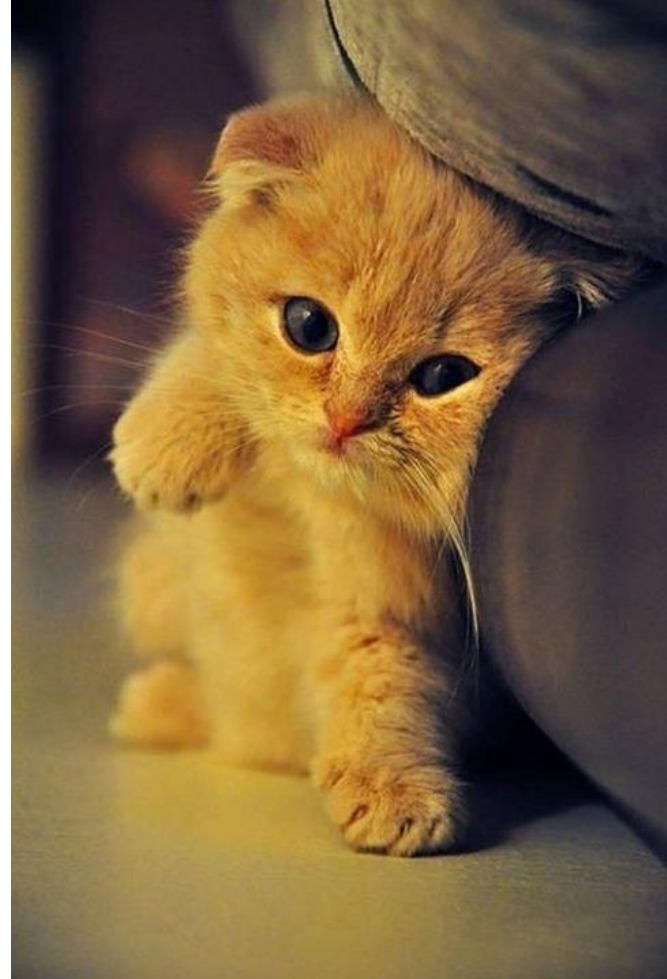
Today: Exam 4 Review

(Extra) office hours for HW8 and Exam4:
see Piazza

Quote of the day:

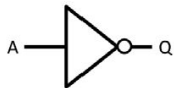
“Inspiration exists, but it has to find you working”

-- Pablo Picasso 1881 - 1973



Cheatsheet

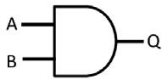
NOT GATE



A	B	Q
0	0	1
0	1	0

Text notation: \sim

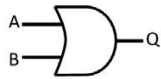
AND GATE



A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

Text notation: \cdot

OR GATE



A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

Text notation: $+$

XOR GATE



A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

Text notation: \oplus

NAND GATE



A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

NOR GATE



A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

XNOR GATE



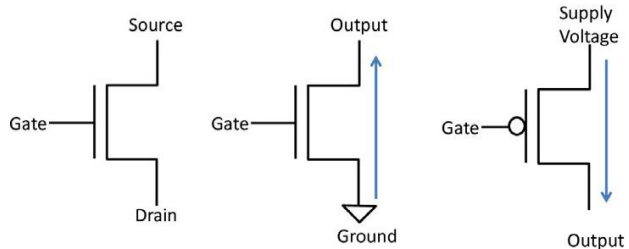
A	B	Q
0	0	1
0	1	0
1	0	0
1	1	1

De Morgan's law

$$\sim(AB) = \sim A + \sim B$$

$$\sim(A + B) = (\sim A)(\sim B)$$

Using other gates



Transistor terminals

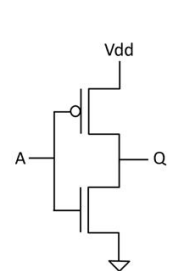
N-type transistor

P-type transistor

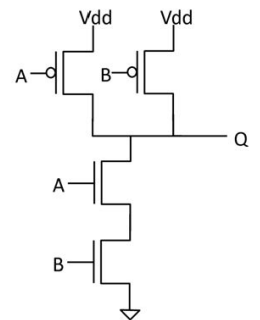
Gate	Behavior
1	Closed Output=0
0	Open Output=Z

Gate	Behavior
0	Closed Output=1
1	Open Output=Z

NOT

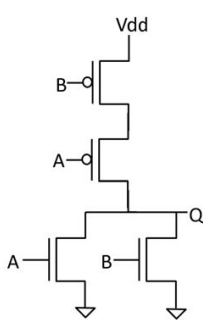


NAND



NAND Gate

NOR



NOR Gate

Outline

- Chapter 8 Topics

- Simple logic gates (AND, OR, NOT, XOR, NAND, NOR, XNOR)
- Multiple inputs on any simple logic gates
- Sum-of-products design for circuits
 - Take any truth table and design a circuit using AND, OR, and NOT gates
- DeMorgan's Law
- Simple circuits, such as multiplexers, full adders, half adders, decoders, encoders, and incrementors.
- Principle behind control signal and next state circuits
- R-S Latch, Gated D-Latch, Master-Slave flip-flop.
- Derive a truth table from a circuit of simple logic gates
- Transistors
 - N-type and P-type, and their operation
 - Understand and derive truth tables for transistor circuits.
 - Components of the transistor and how they affect its function
 - Moore's Law



Find the boolean expression for *Output* from following truth table. The boolean expression should be in terms of A and B and in sum-of-products (SOP) form.

A	B	C	output
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

output =



Fill out the truth table for the following boolean equation.

$$\text{output} = ABC' + AB'C + A'B'C + A'BC' + A'B'C'$$

A	B	C	output
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



Implement the following boolean equation with logic gates.

$$\text{output} = ABC' + AB'C + A'B'C + A'BC' + A'B'C'$$

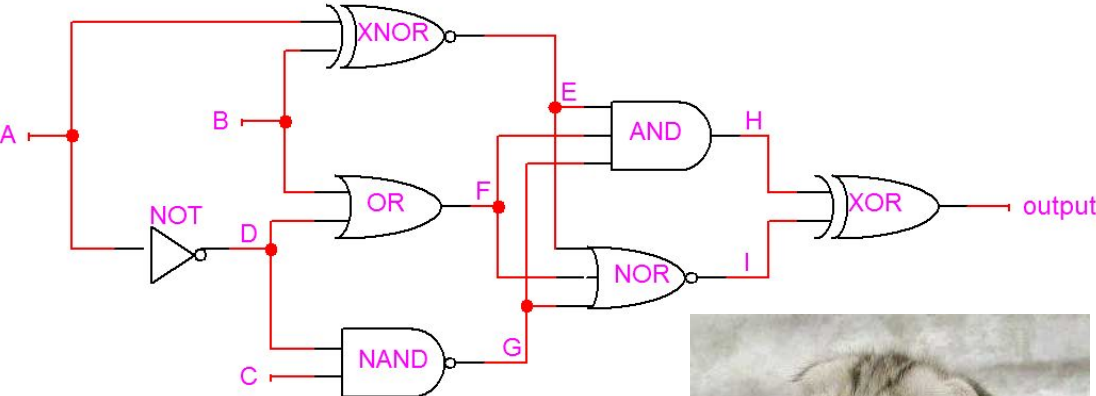


Implement the following boolean equation with logic gates.

$$\text{output} = AB + A'B' + C$$



Fill out the truth table for the logic gate level circuit below.



A	B	C	D	E	F	G	H	I	output
0	0	0	1	1	1	1	1	0	1
0	0	1							
0	1	0							
0	1	1							
1	0	0							
1	0	1							
1	1	0							
1	1	1							

De Morgan's Laws

$$\sim(AB) = \sim A + \sim B$$

given by cheatsheet

$$\sim(XY) = \sim X + \sim Y$$

by rewriting and changing variable name

$$(XY)' = X' + Y'$$

by rewriting and changing negation notation for better visualization

$$(XYZ)' = X' + Y' + Z'$$

by expanding previous line to 3 terms

$$\sim(A+B) = (\sim A)(\sim B)$$

given by cheatsheet

$$(X+Y+Z)' = X'Y'Z'$$

by applying same algorithm



Compute the negation of the following expression using DeMorgan's Law

$$AB'C + D'E + (A'+B)(C'+D+E')$$

Negation

$$= (AB'C + D'E + (A'+B)(C'+D+E'))'$$
 by negating entire expression

$$= (AB'C)'(D'E)'((A'+B)(C'+D+E'))'$$
 by applying DeMorgan's Law on each of the 3 products

$$= (AB'C)'(D'E)'((A'+B)' + (C'+D+E'))'$$
 by applying DeMorgan's Law on the rightmost product

$$= (A'+B+C')(D+E)'((AB') + (CD'E))$$
 by applying DeMorgan's law on each sum on the rightmost product

$$= (A'+B+C')(D+E)'(AB'+CD'E)$$
 by removing unnecessary parentheses



Compute the negation of the following expression using DeMorgan's Law

$$(A'+B+C')(D+E')(AB'+CD'E)$$

Negation

$$= ((A'+B+C')(D+E')(AB'+CD'E))' \text{ by negating entire expression}$$

$$= (A'+B+C')'+(D+E')'+(AB'+CD'E)' \text{ by applying DeMorgan's Law on each of the 3 sums}$$

$$= (AB'C)+(D'E)+((AB')'(CD'E)') \text{ by applying DeMorgan's Law on each sum}$$

$$= (AB'C)+(D'E)+((A'+B)(C'+D+E')) \text{ by applying DeMorgan's law on each product on the rightmost sum}$$

$$= AB'C+D'E+(A'+B)(C'+D+E') \text{ by removing unnecessary parentheses,}$$

which matches our original expression



What is the difference between a latch and a flip-flop?



If the figure on the left is a (musical) conductor, then what is the figure on the right?



Multiple Choice Question

What does 22nm transistors mean?

- a. the channel length is 22nm
- b. the distance between source and drain is 22nm
- c. the technology node is 22nm
- d. all of the above
- e. none of the above



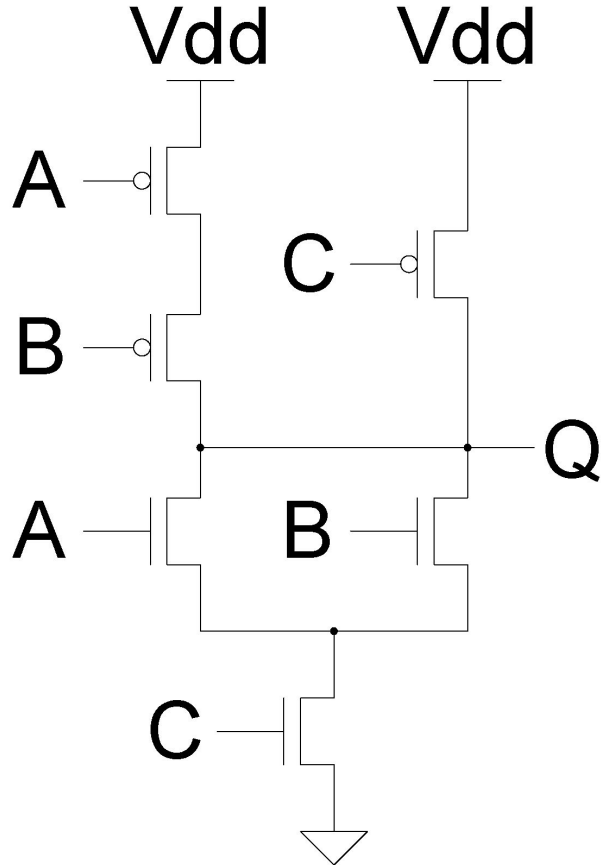
Transistor Behavior

What are the three terminals on a transistor?

How does a transistor (pmos) function when it is ON?



Fill out the truth table for the following circuit



A	B	C	Q
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



What is Dennard Scaling?

