Ryerson University

Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

Course Title:	Digital systems
Course Number:	COE 328
Semester/Year (e.g.F2016)	Fall 2022

Instructor:	Shazzat Hossain

Assignment/Lab Number:	2 - Pre-lab
Assignment/Lab Title:	function implementation and minimization

Submission Date:	2022/09/27
Due Date:	2022/09/28

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1) 1. Determine 2 ways to implement an inverter with a 2-input NAND gate.

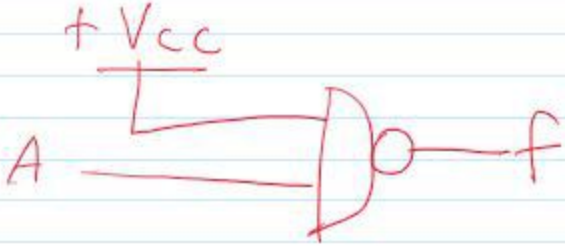
inverter example

X_1	f
0	1
1	0

for nand gate to act like inverter

↓

we put 1 variable X_1 to act as 2 inputs



using +Vcc to implement an inverter gate

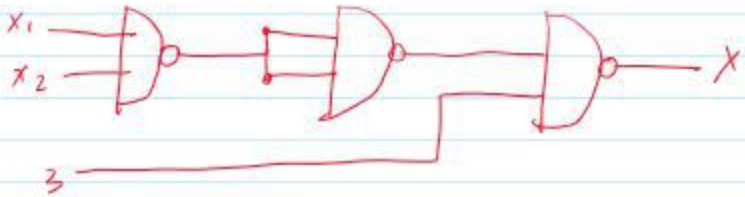
2)

2. Implement a 3-input NAND gate function using 2-input NAND gates only, draw schematics.

3 input NAND gate

X_1	X_2	X_3	f
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

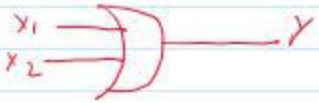
this acts like inverter gate



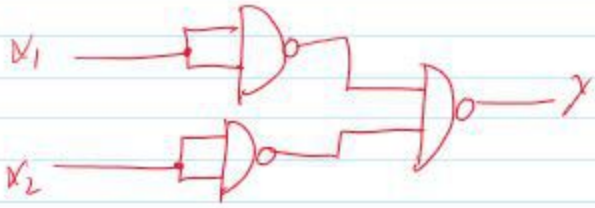
3. Implement a 2-input OR function using 2-input NAND gates only, draw schematics.

3)

2 input or gate



X_1	X_2	Y
0	0	0
0	1	1
1	0	1
1	1	1



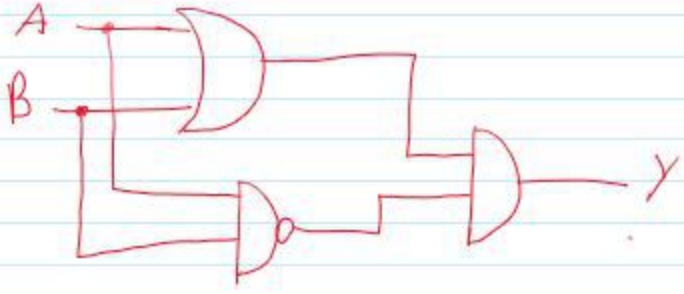
4. (A) Implement the function $Z = f(A, B) = (A + B)\overline{AB}$ using one 2-input OR gate, one 2-input AND gate and one 2-input NAND gate.

and

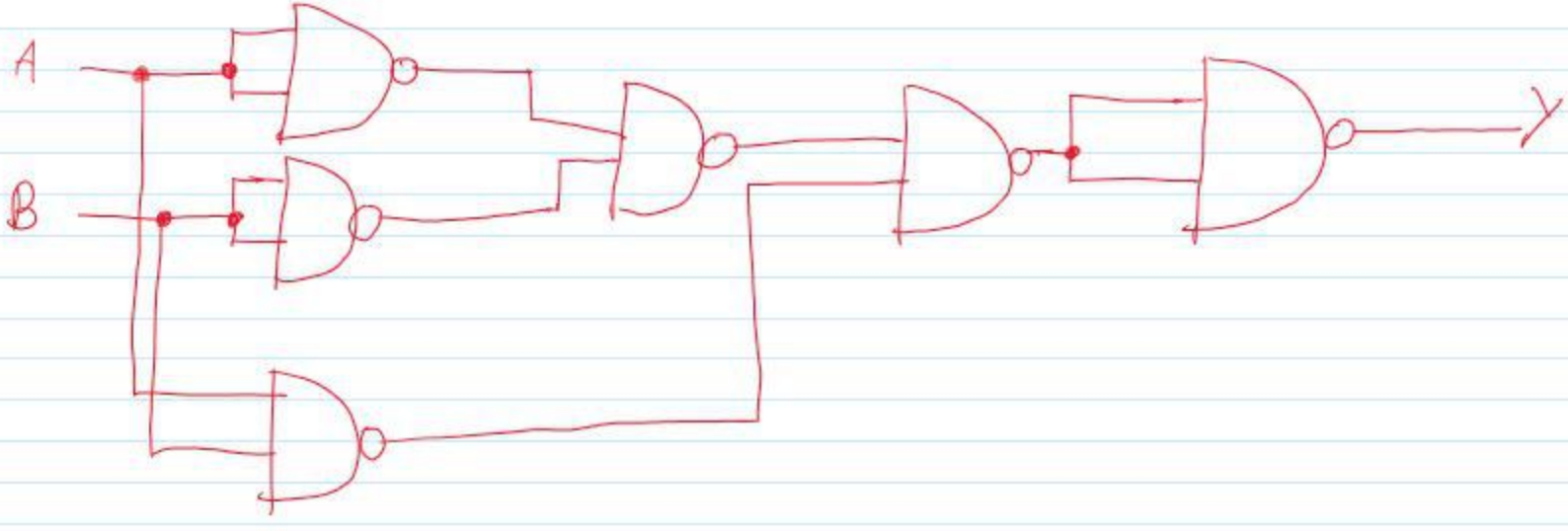
NAND

OR

4)



(B) Implement the same function Z with only NAND gates.



(C) Make up the truth table for the function. What is the common name of this function?

Making truth table

A	B	A+B (or)	A·B (and)	$\overline{A \cdot B}$ (Nand)	Z
0	0	0	0	1	0
0	1	1	0	1	1
1	0	1	0	1	1
1	1	1	1	0	0

the common name of this function is called an XOR Gate

XOR = $A \oplus B$

(D) Expand and simplify the Boolean equation to express Z as a sum of products. Implement the sum of products using only NAND gates. Note: It is possible to do so with 4 NAND gates and no additional inverters.

$$Z = (A+B)\cdot\overline{AB}$$

$$Z = A\overline{AB} + B\overline{AB}$$

$$Z = A(\bar{A}+\bar{B}) + B(\bar{A}+\bar{B})$$

$$Z = \cancel{A\bar{A}} + A\bar{B} + B\bar{A} + \cancel{B\bar{B}}$$

$$Z = A\bar{B} + B\bar{A}$$

$$Z = A\bar{B} + \bar{A}B$$

$$Z = f(A,B)$$