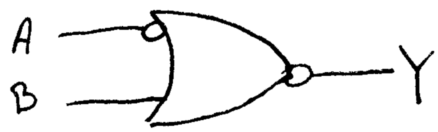
Yengkong Sayaovong
Student ID: 1217194316
Homework # 1

Problem # 1:

Show a truth table for each of the following circuits

(A)

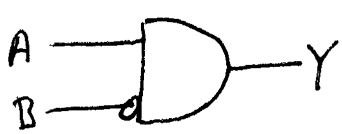


$Y = \overline{\bar{A} + B}$

Truth Table:

A	B	$\bar{A}$	$\bar{A} + B$	$Y = \overline{\bar{A} + B}$
0	0	1	1	0
0	1	1	1	0
1	0	0	0	1
1	1	0	1	0

(B)

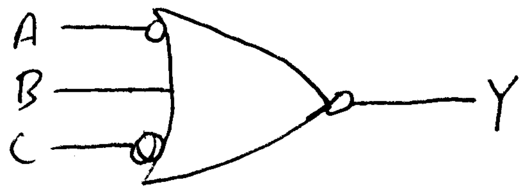


$Y = A \cdot \bar{B}$

Truth table:

A	B	$\bar{B}$	$Y = A \cdot \bar{B}$
0	0	1	0
0	1	0	0
1	0	1	1
1	1	0	0

(C)

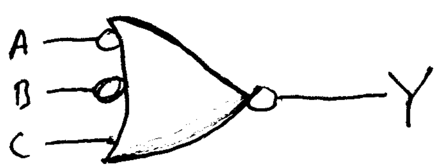


$$Y = \overline{\bar{A} + B + \bar{C}}$$

Truth table :

A B C	$\bar{A}$ $\bar{C}$	$\bar{A}+D+\bar{C}$	Y
0 0 0	1 1	1	0
0 0 1	1 0	1	0
0 1 0	1 1	1	0
0 1 1	1 0	1	0
1 0 0	0 1	1	0
1 0 1	0 0	0	1
1 1 0	0 1	1	0
1 1 1	0 0	1	0

(D)

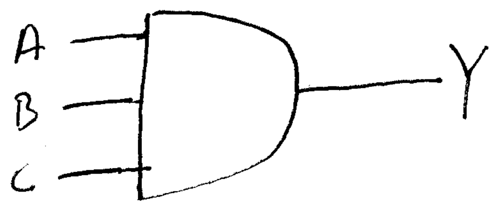


$$Y = \overline{\bar{A} + \bar{B} + C}$$

Truth table :

A ·B C	$\bar{A}$ ·$\bar{B}$	$\bar{A}+\bar{B}+C$	Y
0 0 0	1 1	1	0
0 0 1	1 1	1	0
0 1 0	1 0	1	0
0 1 1	1 0	1	0
1 0 0	0 1	1	0
1 0 1	0 1	1	0
1 1 0	0 0	0	1
1 1 1	0 0	1	0

(E)



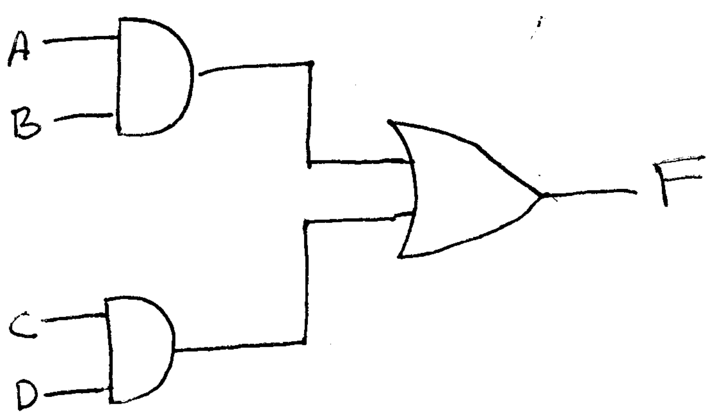
$Y = A \cdot B \cdot C$

Truth Table:

A	B	C	$Y = ABC$
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Problem 2:

Determine, using a truth table, whether the two circuits are equivalent in terms of logic.



$F = AB + CD$

AND

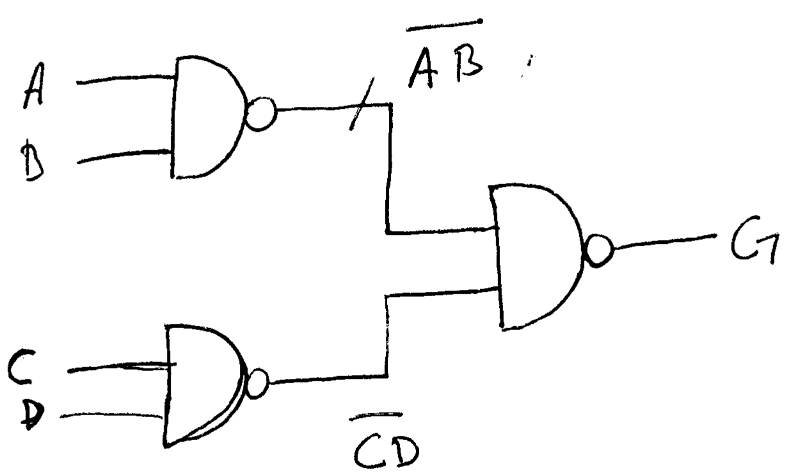
A	B	O/P
0	0	0
0	1	0
1	0	0
1	1	1

$2^2 = 4$ inputs

AND

C	D	O/P
0	0	0
0	1	0
1	0	0
1	1	1

AB	CD	$F = AB + CD$
0	0	0
0	1	0
1	0	0
1	1	1



NAND GATE

A	B	O/P
0	0	1
0	1	1
0	0	1
1	1	0

C	D	O/P
0	0	1
0	1	1
1	0	1
1	1	0

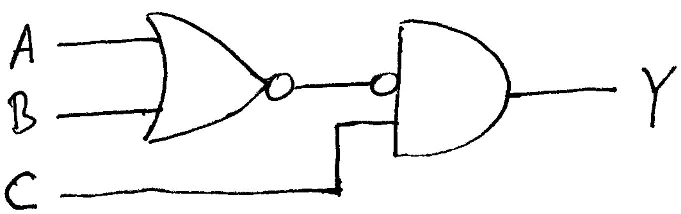
AB	CD	G = ABCD
1	1	0
1	1	0
1	1	0
0	0	1

Both gates have the same truth table so the two circuits are equivalent in terms of logic.

Problem 3:

Show a truth table for each of the following circuits.

(A)



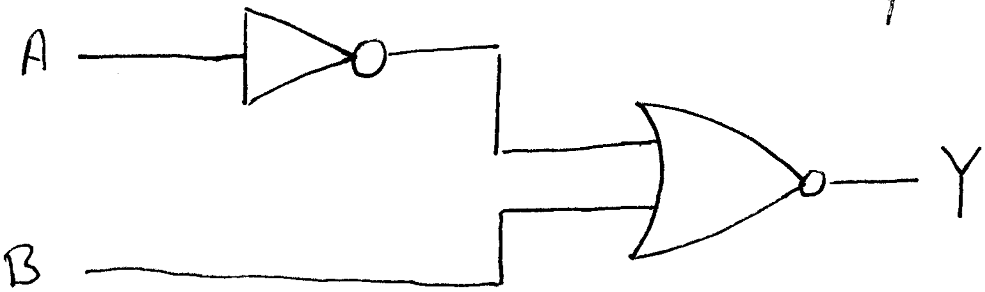
$Y = (\overline{\overline{\bar{A}+B}})\,C$

Truth table:

A	B	C	$\bar{A}$	$\bar{A}+B$	$\overline{\bar{A}+B}$	$\overline{\overline{\bar{A}+B}}$	Y
0	0	0	1	1	0	1	0
0	0	1	1	1	0	1	1
0	1	0	1	1	0	1	0
0	1	1	1	1	0	1	1
1	0	0	0	0	1	0	0
1	0	1	0	0	1	0	0
1	1	0	0	1	0	1	0
1	1	1	0	1	0	1	1

(B)

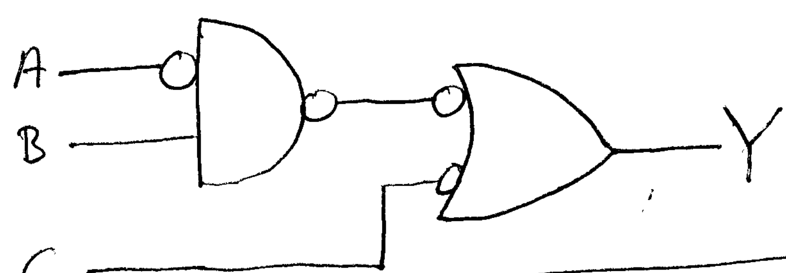
$$Y = \overline{\bar{\bar{A}} + B}$$



Truth table:

A	B	$\bar{A}$	$\bar{\bar{A}}$	$\bar{\bar{A}} + B$	Y
0	0	1	0	0	1
0	1	1	0	1	0
1	0	0	1	1	0
1	1	0	1	1	0

(C)



$$Y = \overline{\overline{\overline{\bar{A}B}} + \bar{C}}$$

Truth table:

A	B	C	$\bar{A}$	$\bar{A}B$	$\overline{\bar{A}B}$	$\overline{\overline{\bar{A}B}}$	$\bar{C}$	Y
0	0	0	1	0	1	0	1	1
0	0	1	1	0	1	0	0	0
0	1	0	1	1	0	1	1	1
0	1	1	1	1	0	1	0	1
1	0	0	0	0	1	0	1	1
1	0	1	0	0	1	0	0	0
1	1	0	0	0	1	0	1	1
1	1	1	0	0	1	0	0	0

Problem 4:

You are asked to build a digital logic circuit for a security alarm system. The system has ~~four~~ motion sensors which indicate the presence of an intruder. Each individual motion sensor should be able to trigger an alarm. The system should be completely disabled via a master switch. In addition, the siren, the flashlight and the automated call to security company should have separate enable switches. The inputs and outputs are specified as below:

Inputs: S_1, S_2, S_3, S_4: Motion Sensors (0 = no intrusion, 1 = intrusion)

M: Master switch: (0 = security disabled, 1 = security enabled)

A: Audible Alarm Enable switch: (0 = audible alarm disabled, 1 = audible alarm enabled)

L: Light Enable Switch: (0 = flash light disabled, 1 = flash light enabled)

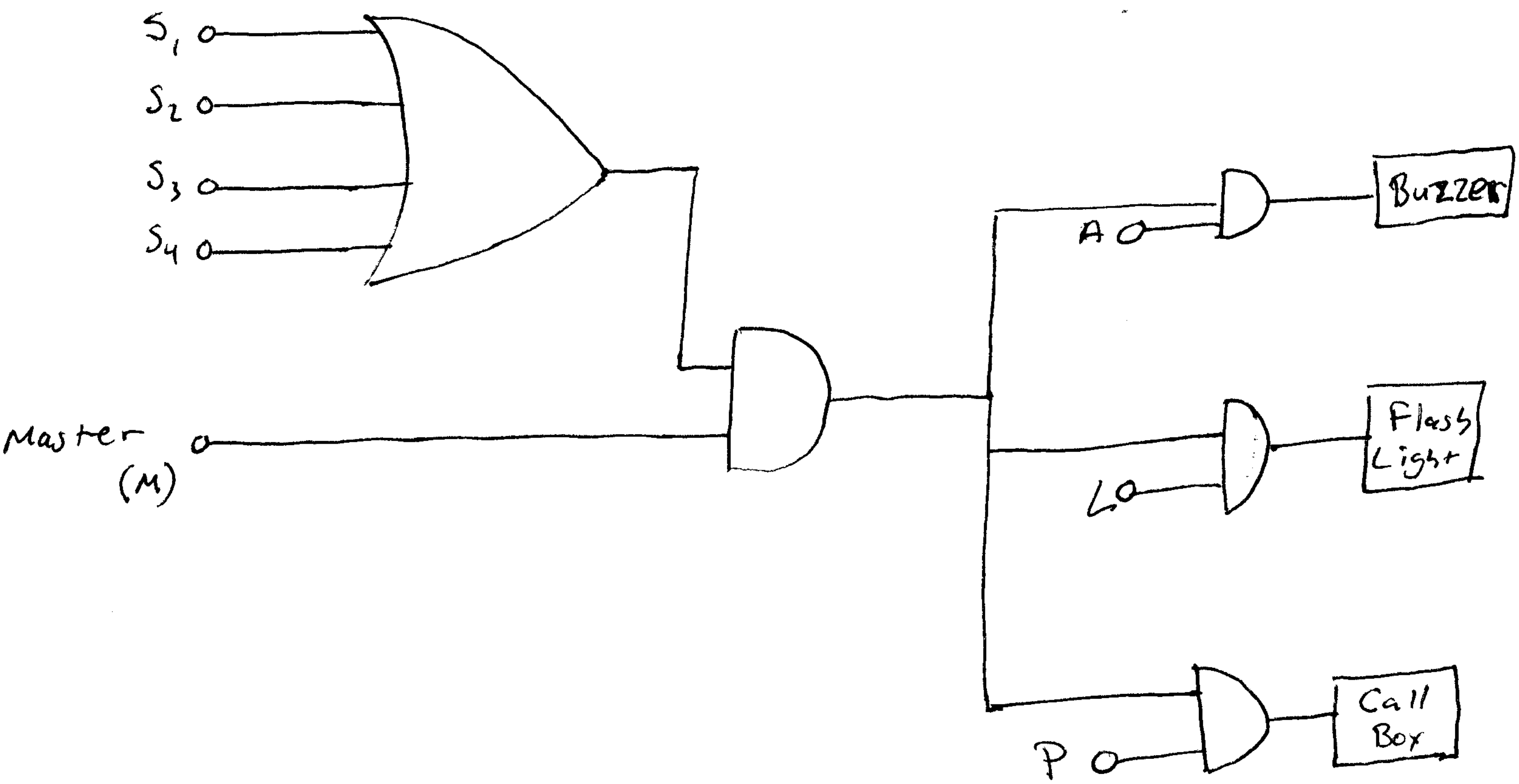
P: Phone Call enable switch: (0 = call disabled, 1 = call enabled)

Outputs: B: Alarm Buzzer

F: Flash Light

C: Call Box

Draw the logic circuit diagram of the digital logic using AND and OR gates inverters.



Truth Table

x = don't care

Input								Output		
M	S_1	S_2	S_3	S_4	A	L	P	B	F	C
0	X	X	X	X	X	X	X	—	—	—
1	1	X	X	X	1	0	0	1	0	0
1	X	1	X	X	0	1	0	0	1	0
1	X	X	1	X	0	0	1	0	0	1
1	1	1	X	X	1	1	0	1	1	0
1	1	1	1	X	1	0	1	1	0	1
1	1	1	1	1	1	1	1	1	1	1

If at least one of the input sensors gets activated then the output will come on.

Problem 5:

The security alarm system you designed in problem 4 has an issue that it accidentally gets triggered by pets. You considered improving the system by triggering an alarm only if at least two motion sensors are activated at the same time. Show a truth table that has the four motion sensors as inputs and an alarm trigger as the output which shows how to implement the improved security system design.

Inputs								Outputs		
M	S_1	S_2	S_3	S_4	A	L	P	B	F	C
0	X	X	X	X	X	X	X	—	—	—
1	1	0	0	0	X	X	X	—	—	—
1	1	1	0	0	1	0	0	1	0	0
1	0	0	1	1	0	1	0	0	1	0
1	X	1	X	1	0	0	1	0	0	1
1	X	1	1	X	1	1	0	1	1	0
1	1	X	X	1	1	0	1	1	0	1
1	1	X	1	X	1	1	1	1	1	1

Problem 6:

Design a 4-input XOR gate circuit that outputs a 1 if the number of 1's on the four inputs A, B, C, D is odd.

Truth Table:

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

Problem 7:

Design a minority gate for three inputs. The outputs of such a gate becomes 1 if a smaller number of inputs is 1 than 0. Show a truth table and a logic gate implemation using AND and OR gates and inverters.

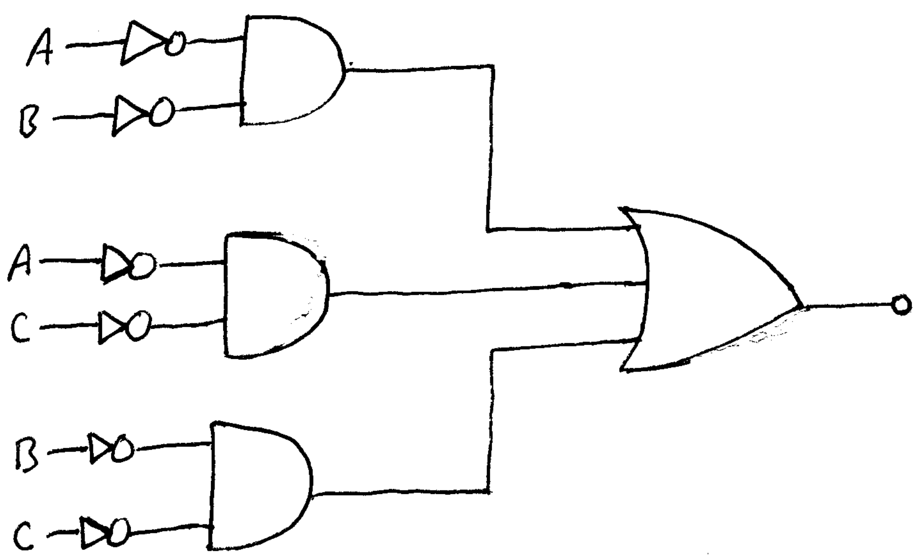
Truth table:

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

K-map:

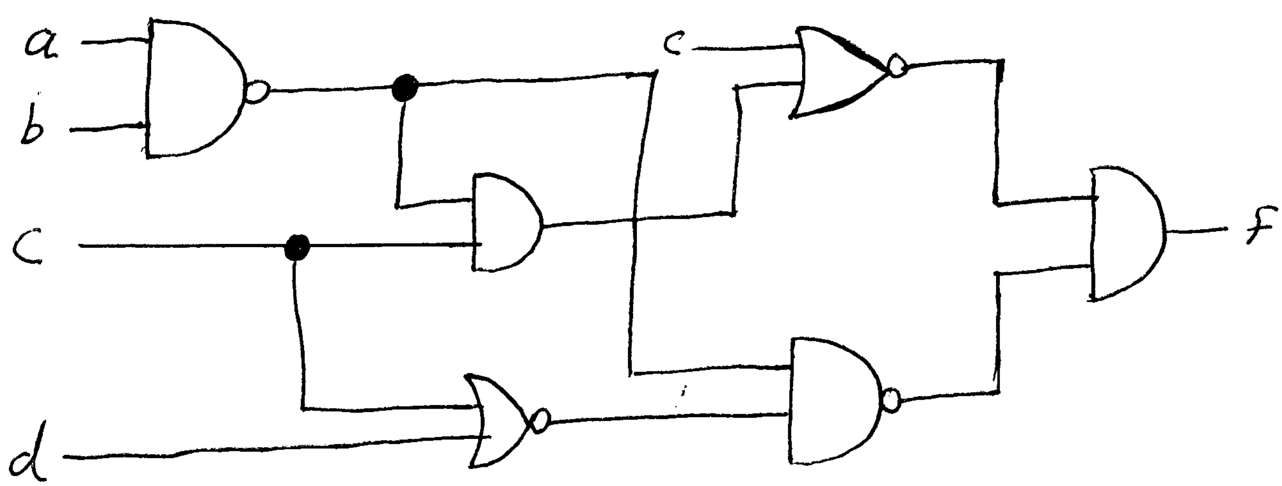
A \ BC	00	01	10	11
0	1	1	0	1
1	1	0	0	0

Logic gate:



Problem 8:

Construct the truth table for the following circuit:



Truth Table

a	b	c	d	$\overline{ab}$	$\overline{c+d}$	$\overline{c + \overline{ab}c}$	$\overline{ab} \cdot [\overline{c+d}]$	$(\overline{c + \overline{ab} \cdot c}) \cdot \overline{ab} \cdot [\overline{c+d}])$
0	0	0	0	1	1	1	0	0
0	0	0	1	1	0	1	1	1
0	0	1	0	1	0	0	1	0
0	0	1	1	1	0	0	1	0
0	1	0	0	1	1	1	0	0
0	1	0	1	1	0	1	1	1
0	1	1	0	1	0	0	1	0
0	1	1	1	1	0	0	1	0
1	0	0	0	1	1	1	0	0
1	0	0	1	1	0	1	1	1
1	0	1	0	1	0	0	1	0
1	0	1	1	1	0	0	1	0
1	1	0	0	0	1	1	1	1
1	1	0	1	0	0	1	1	1
1	1	1	0	0	0	0	1	0
1	1	1	1	0	0	0	1	0