



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

SUBJECT: SECR1013 DIGITAL LOGIC

SESSION/SEM: 1/1

LAB 2: COMBINATIONAL LOGIC CIRCUIT DESIGN SIMULATION

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DATE: 18/1/2021

REMARKS:

MARKS:

Lab 2: Combinational Digital Circuit Design Simulation Using Deeds Simulator

D: Lab Activities

Part 1

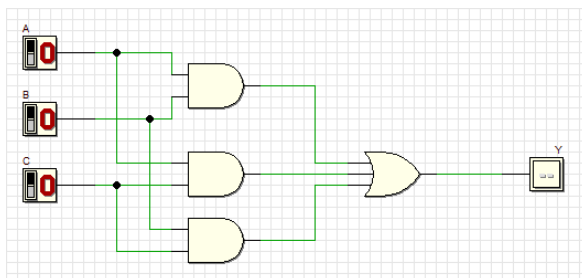
1.

$$\begin{aligned} 1. \quad Y &= AB + BC + AC \\ &= ABC + AB\bar{C} + ABC + \bar{A}BC + ABC + A\bar{B}C \\ &= ABC + AB\bar{C} + \bar{A}BC + A\bar{B}C \end{aligned}$$

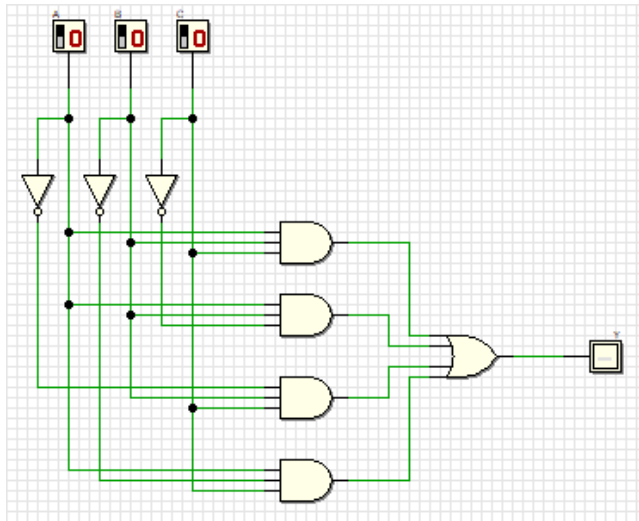
2.

Input			Output
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

3.(a) Circuit (i)

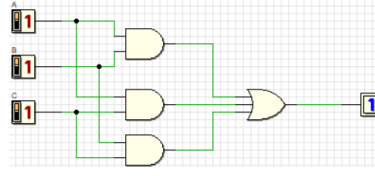
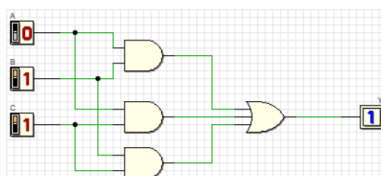
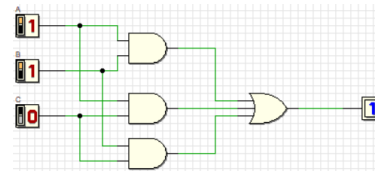
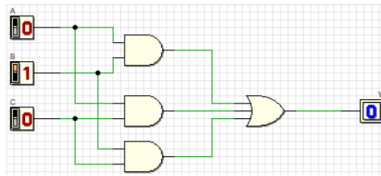
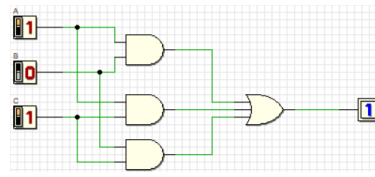
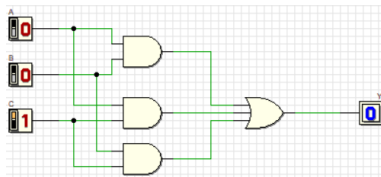
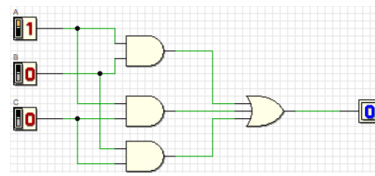
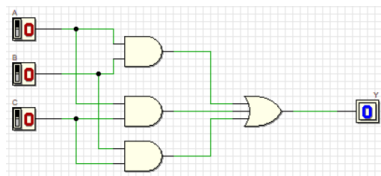


3.(b) Circuit (ii)

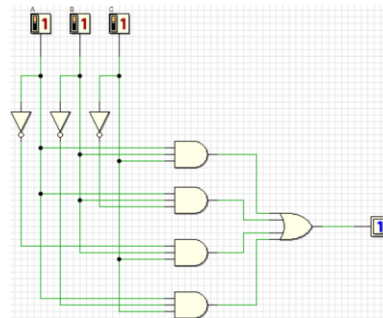
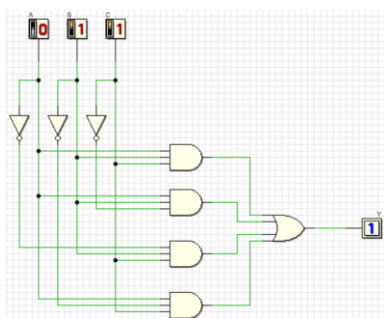
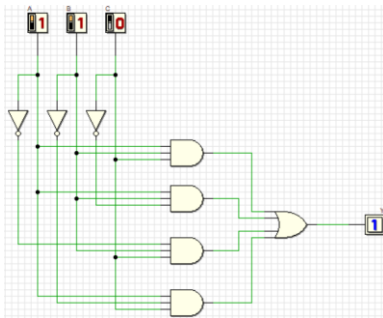
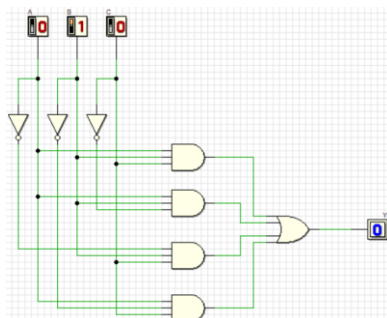
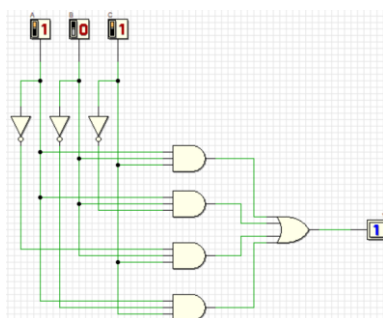
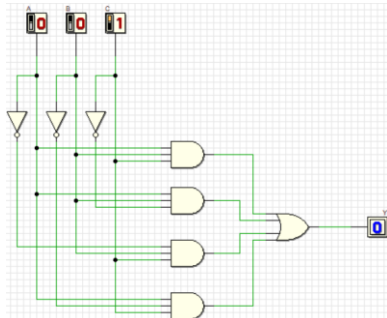
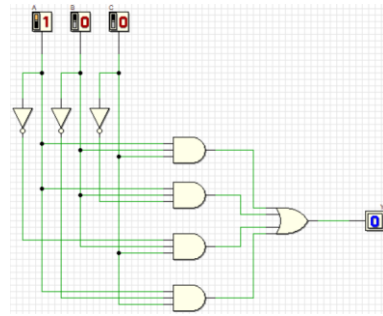
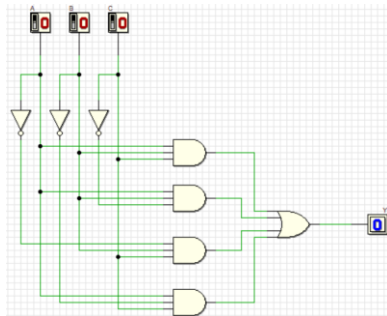


4.

Circuit (i)



Circuit (ii)



Circuit (i)

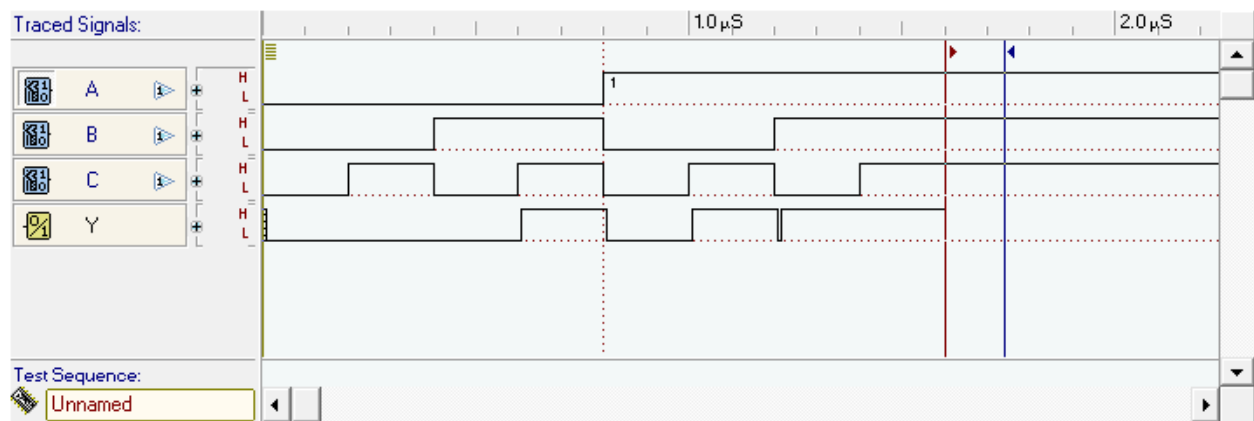
Input			Output
A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Circuit (ii)

Input			Output
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

Both Circuit (i) and Circuit (ii) produce same output. The non-standard expression is the simplified expression from standard expression.

5.



Sum-of-Products (SOP) form is used at the Boolean expression above. In SOP form, product terms are summed while the output produced for product terms in truth table is 1(high). The product terms for Boolean expression above are ABC , ABC' , $A'BC$ and $AB'C$. Hence, the input values of 111, 110, 011 and 101 will produce high output value, which is 1.

Part 2

1.

Truth table 1:

A = negative = 1 0 = EVEN A = positive = 0									
	Input				Output				
	A	B	C	D	E1	E2	E3	E4	
0	0	0	0	0	0	1	0	0	
1	0	0	0	1	1	0	0	0	
2	0	0	1	0	0	1	0	0	
3	0	0	1	1	X	X	X	X	
4	0	1	0	0	0	1	0	0	
5	0	1	0	1	X	X	X	X	
6	0	1	1	0	X	X	X	X	
7	0	1	1	1	0	0	0	0	
									2's 1's
-8	1	0	0	0	0	0	0	0	$1000 \rightarrow 0111+1 \rightarrow 1000 \rightarrow 8$
-7	1	0	0	1	X	X	X	X	$1001 \rightarrow 0110+1 \rightarrow 0111 \rightarrow 7$
-6	1	0	1	0	X	X	X	X	$1010 \rightarrow 0101+1 \rightarrow 0110 \rightarrow 6$
-5	1	0	1	1	0	0	1	0	$1011 \rightarrow 0100+1 \rightarrow 0101 \rightarrow 5$
-4	1	1	0	0	X	X	X	X	$1100 \rightarrow 0011+1 \rightarrow 0100 \rightarrow 4$
-3	1	1	0	1	0	0	1	0	$1101 \rightarrow 0010+1 \rightarrow 0011 \rightarrow 3$
-2	1	1	1	0	0	0	0	1	$1110 \rightarrow 0001+1 \rightarrow 0010 \rightarrow 2$
-1	1	1	1	1	0	0	1	0	$1111 \rightarrow 0000+1 \rightarrow 0001 \rightarrow 1$

2.

AB \ CD	00	01	11	10
00		1	X	
01		X		X
11	X			
10		X		X

$E1 = \bar{A}\bar{B}D$

AB \ CD	00	01	11	10
00	1		X	1
01	1	X		X
11	X			
10		X		X

$E2 = \bar{A}\bar{D}$

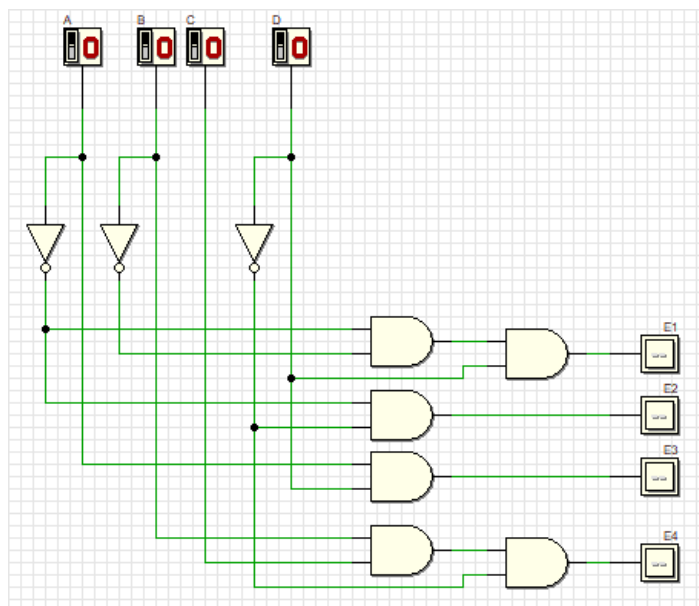
AB \ CD	00	01	11	10
00			X	
01		X		X
11	X	1	1	
10		X	1	X

$E3 = AD$

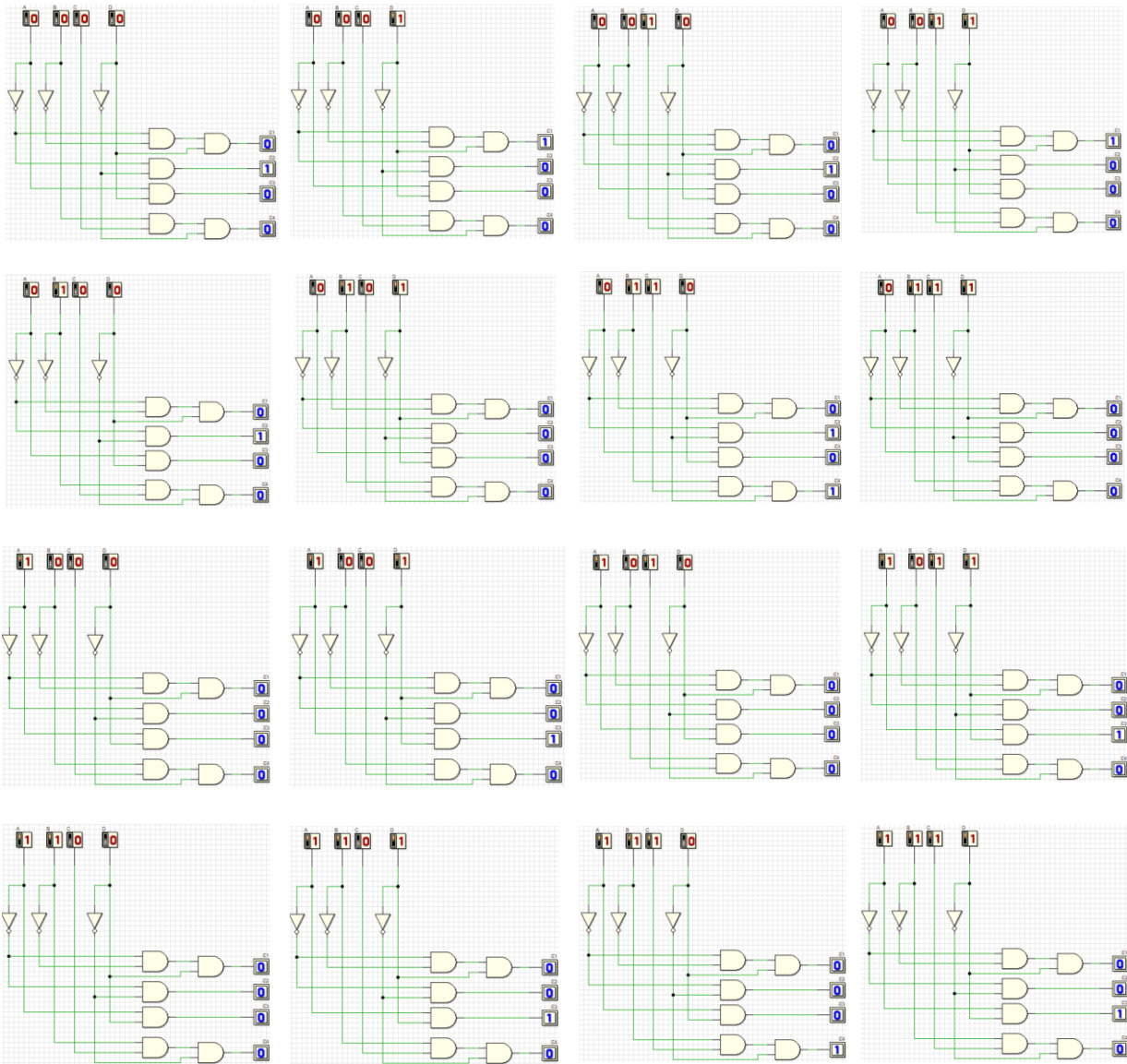
AB \ CD	00	01	11	10
00			X	
01		X		X
11	X			1
10		X		X

$E4 = BC\bar{D}$

3.



4.

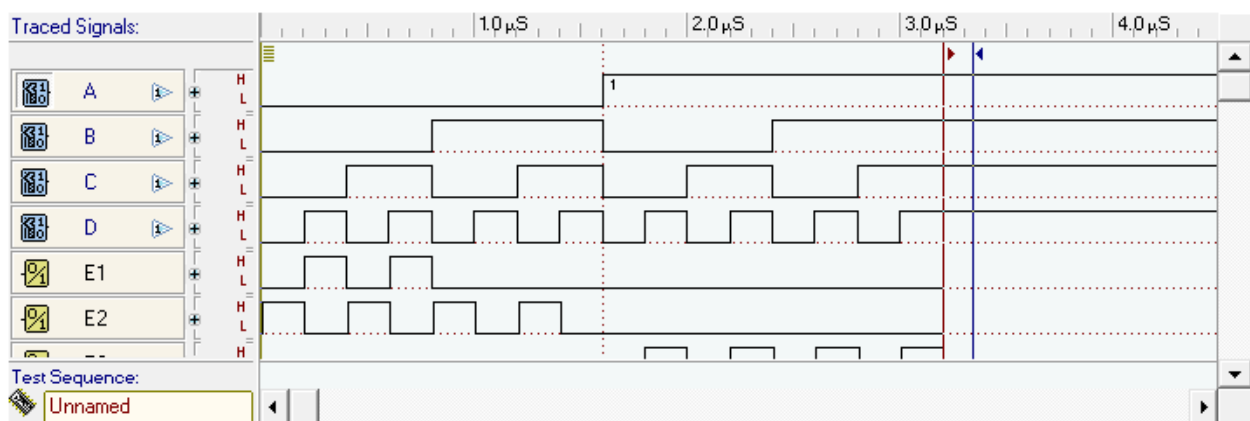


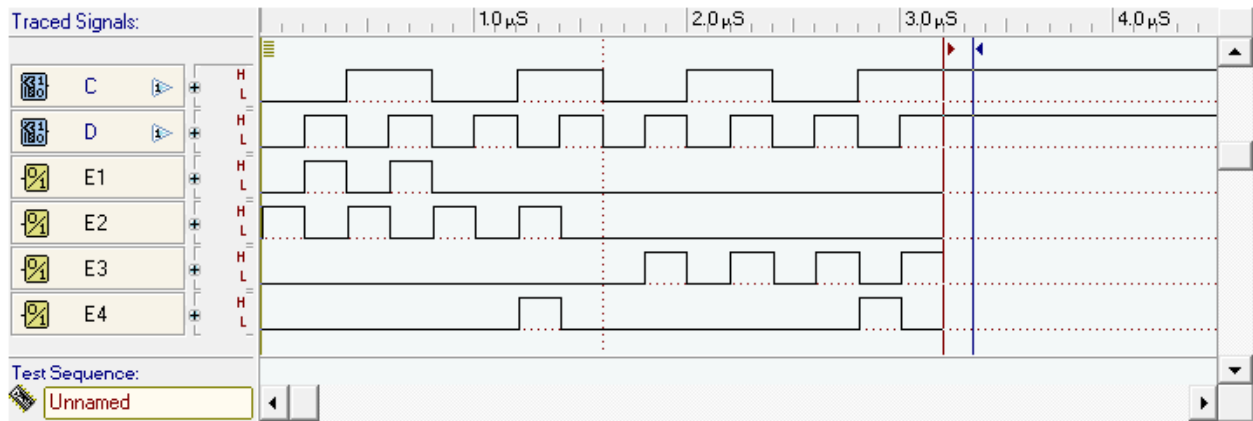
4.(a) Truth table 2:

Input				Output			
A	B	C	D	E1	E2	E3	E4
0	0	0	0	0	1	0	0
0	0	0	1	1	0	0	0
0	0	1	0	0	1	0	0
0	0	1	1	1	0	0	0
0	1	0	0	0	1	0	0
0	1	0	1	0	0	0	0
0	1	1	0	0	1	0	1
0	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0
1	0	0	1	0	0	1	0
1	0	1	0	0	0	0	0
1	0	1	1	0	0	1	0
1	1	0	0	0	0	0	0
1	1	0	1	0	0	1	0
1	1	1	0	0	0	0	1
1	1	1	1	0	0	1	0

The result in Truth table 1 are different with Truth table 2. This is because X is don't care and can be 0 or 1.

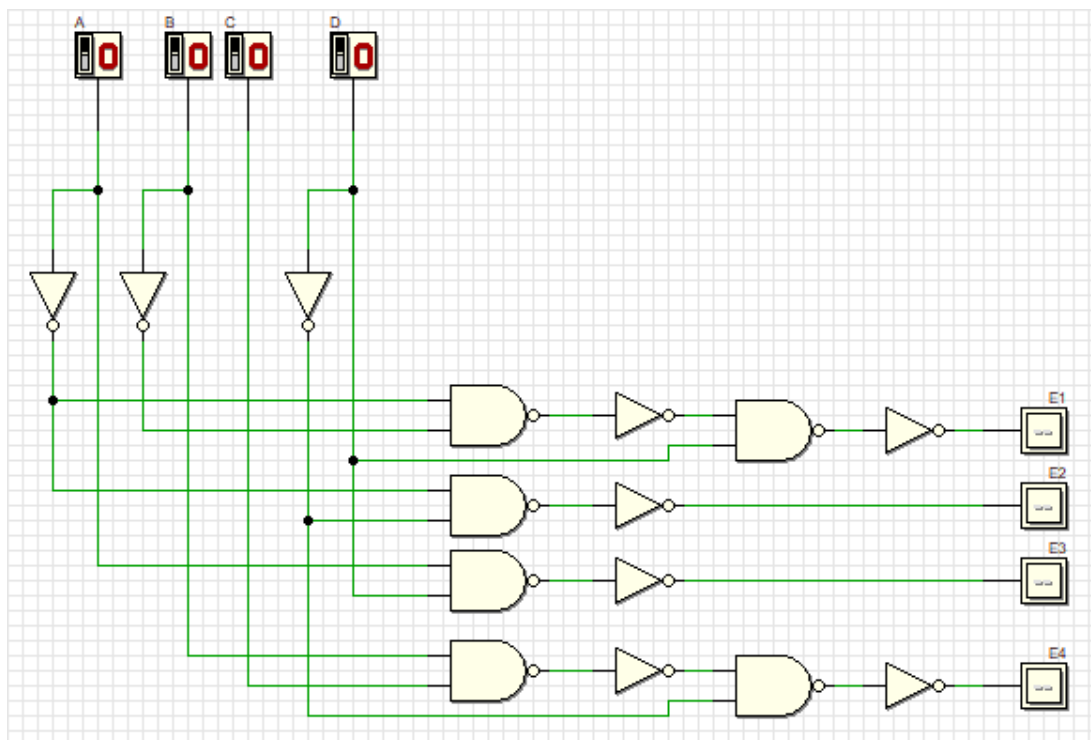
4.(b) Timing diagram

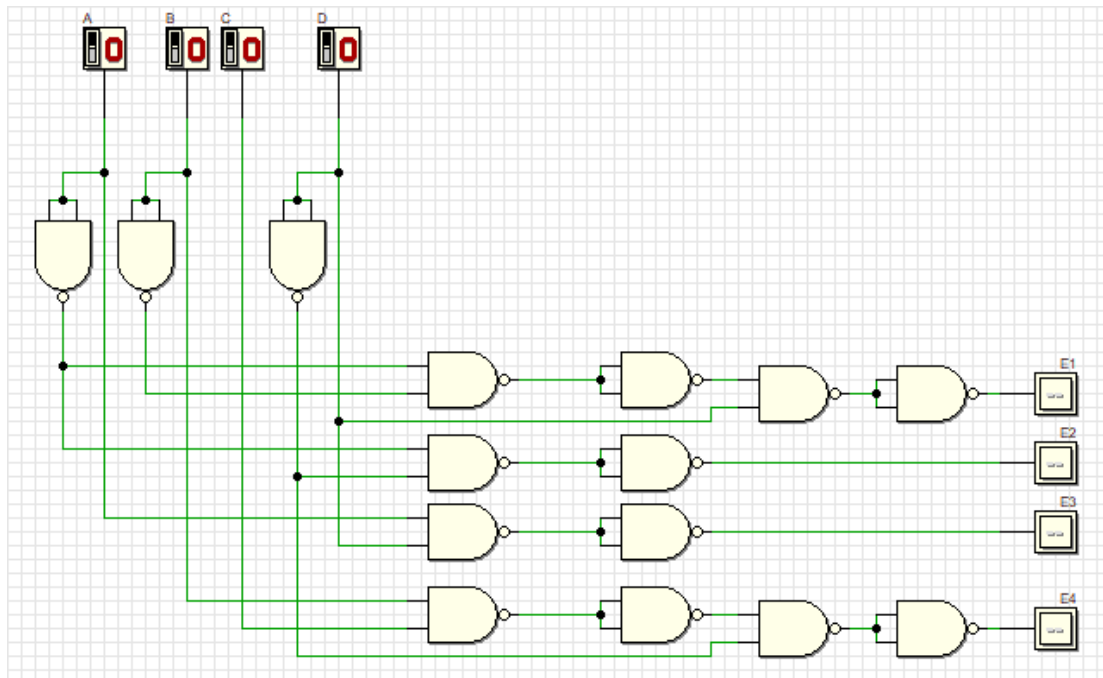




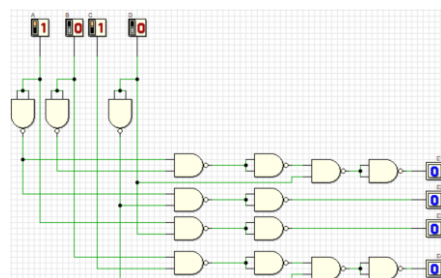
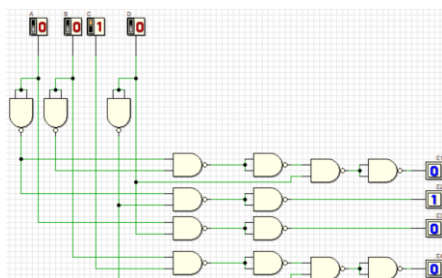
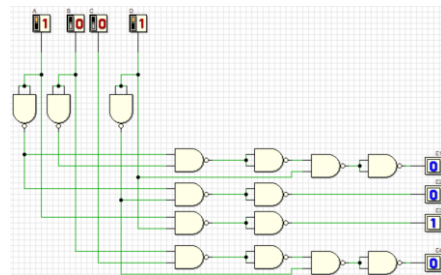
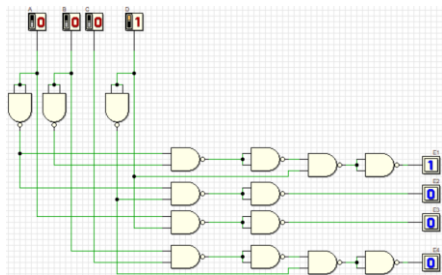
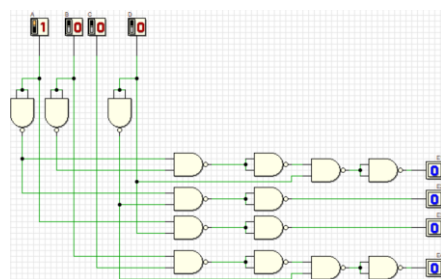
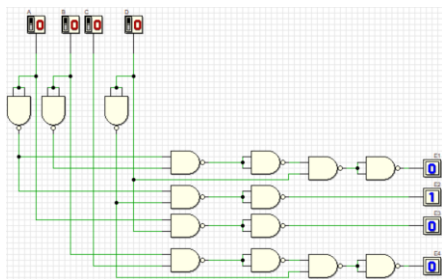
The Boolean expression above is in Sum-of-Products (SOP) form. In SOP form, the output produced in truth table is high, which is 1. The product terms derived from Boolean expression are $A'B'D$, $A'D'$, AD , BCD' . Hence, the input values 0001 and 0011 produce high output E1, input values 0000, 0010, 0100 and 0110 produce high output E2, input values 1001, 1011, 1101 and 1111 produce high output E3, input values 0110 and 1110 produce high output E4.

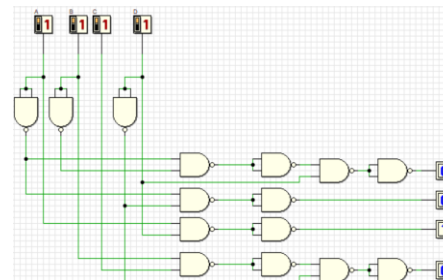
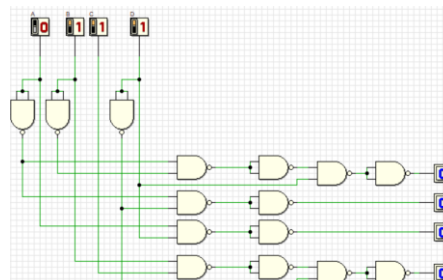
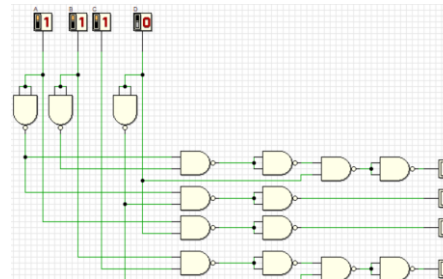
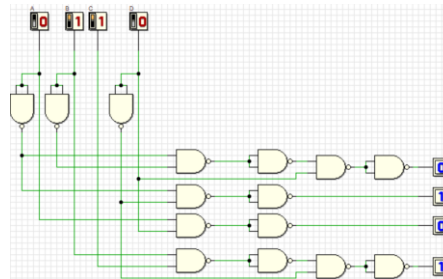
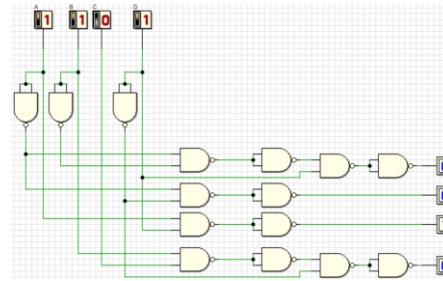
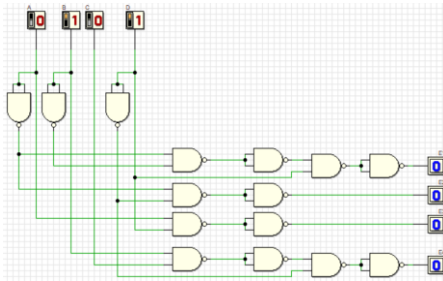
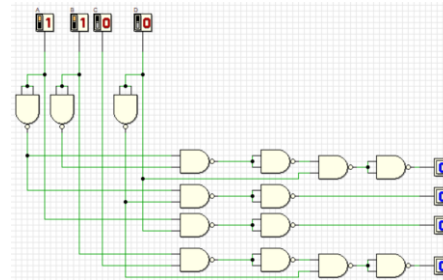
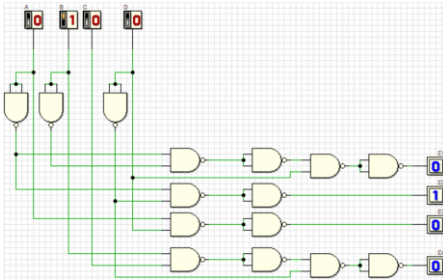
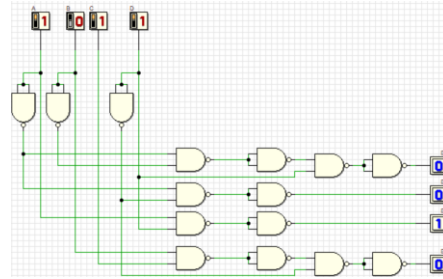
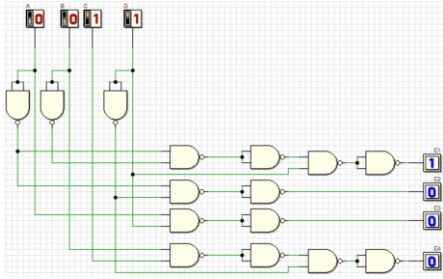
5.





6.



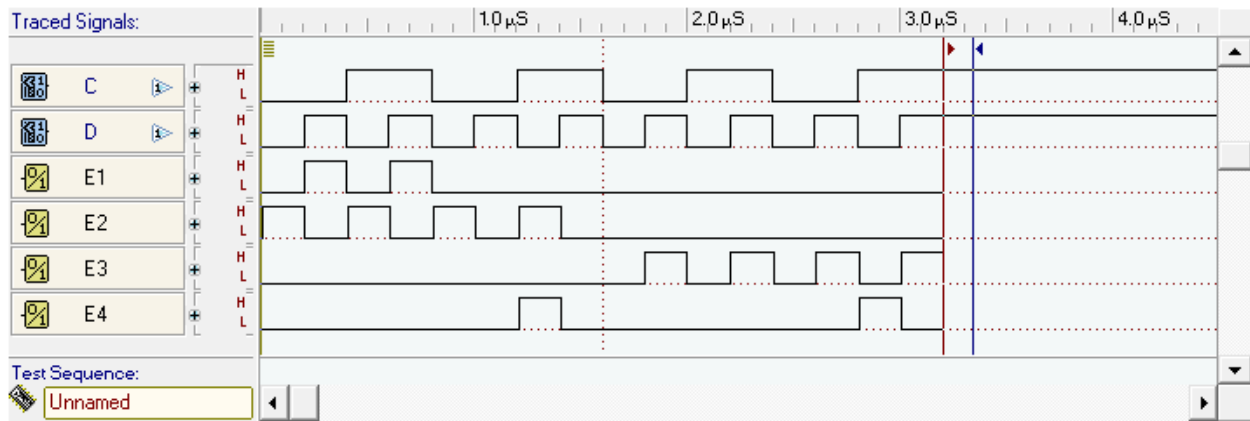
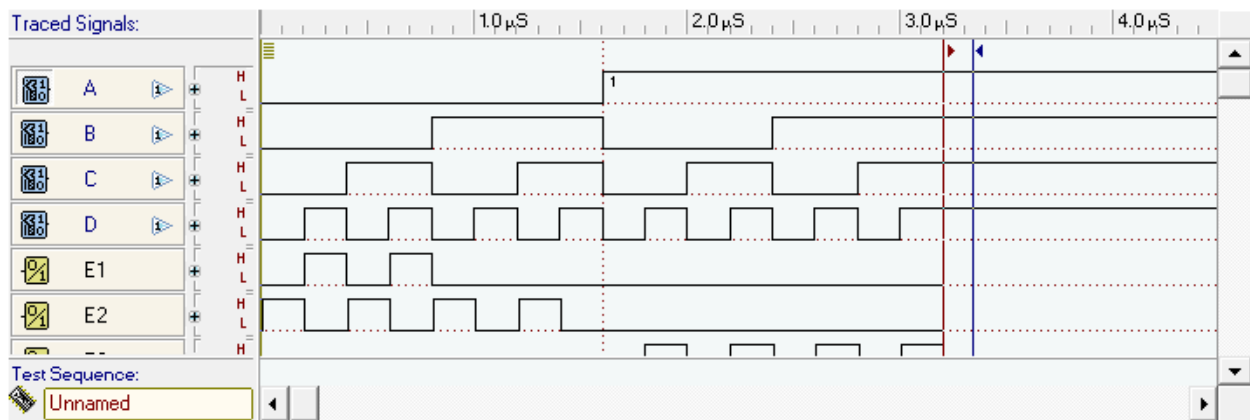


6.(a) Truth table 3:

Input				Output			
A	B	C	D	E1	E2	E3	E4
0	0	0	0	0	1	0	0
0	0	0	1	1	0	0	0
0	0	1	0	0	1	0	0
0	0	1	1	1	0	0	0
0	1	0	0	0	1	0	0
0	1	0	1	0	0	0	0
0	1	1	0	0	1	0	1
0	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0
1	0	0	1	0	0	1	0
1	0	1	0	0	0	0	0
1	0	1	1	0	0	1	0
1	1	0	0	0	0	0	0
1	1	0	1	0	0	1	0
1	1	1	0	0	0	0	1
1	1	1	1	0	0	1	0

Both Truth table 2 and Truth table 3 have same output result. NAND gates only circuit is same with basic gates circuit.

6.(b) Timing diagram



The Boolean expression above is in Sum-of-Products (SOP) form. In SOP form, the output produced in truth table is high, which is 1. The product terms derived from Boolean expression are $A'B'D$, $A'D'$, AD , BCD' . Hence, the input values 0001 and 0011 produce high output E1, input values 0000, 0010, 0100 and 0110 produce high output E2, input values 1001, 1011, 1101 and 1111 produce high output E3, input values 0110 and 1110 produce high output E4.