Muscat College

System I

Code: CSCUMV4

Assignment

*Spring **2021***

"Why-Aye" Controller

A Report

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- **<u>Task Marking Rubric</u>**

Criteria	Ratings	Pts
This criterion is linked to a learning outcomeT1. Build the truth table This criterion is linked to a learning outcome		5.0 pts
This criterion is linked to a learning outcomeT2a. Sum-of-minter’s expressions		12.0 pts
This criterion is linked to a learning outcomeT2b. Simplification of the expression for Clock Wise		16.0 pts
This criterion is linked to a learning outcomeT2c. Simplification of the expression using K-Map This criterion is linked to a learning outcome		14.0 pts
This criterion is linked to a learning outcomeT3. Draw the CW circuit		10.0 pts
This criterion is linked to a learning outcomeT4. Convert CW expression to NAND-only form		18.0 pts
This criterion is linked to a learning outcome This criterion is linked to a learning outcomeT5. Demonstrate NAND-only version is correct with a truth table		10.0 pts
This criterion is linked to a learning outcomeT6. Draw the NAND-only version of the CW circuit This criterion is linked to a learning outcome		10.0 pts
This criterion is linked to a learning outcomeT7. Produce a well-presented submission		5.0 pts
Total points:	100.0	

- **Table of contents:**

- **Introduction**
  One of the most popular titles in Newcastle company is Number 910, which is a special title for the gaming industry, whereas a special console is designed for drunk players, as it contains a control unit of only 4 buttons, it also contains educational games that warning of drug abuse in the event of drunkenness, the logical circuit in this game control to design, if we look on your own for the control of this device, we will find circuits that create a value 1 & 2 in each special wire for existing group of buttons, and then the game is completely simulated using the C programming language.

- **Task 1: Build the truth table**

	1	2	3	4							
	A	**B**	**C**	**D**	**Button**	**CW clockwise**	**ACW anticlockwise**	**L left**	**R right**	**U up**	**D down**
1	0	0	0	0	**None**	0	0	0	0	0	0
2	0	0	0	1	❶	0	0	1	0	0	0
3	0	0	1	0	❷	0	1	0	0	0	0
4	0	0	1	1	❸	0	0	0	1	0	0
5	0	1	0	0	❹	1	0	0	0	0	0
6	0	1	0	1	❶+❷	0	0	0	0	0	1
7	0	1	1	0	❶+❹	0	0	0	0	1	0
8	0	1	1	1	❶+❸	0	1	1	0	0	0
9	1	0	0	0	❷+❹	1	0	1	0	0	0
10	1	0	0	1	❷+❸	0	1	0	1	0	0
11	1	0	1	0	❸+❹	1	0	0	1	0	0
12	1	0	1	1	❶+❷+❸	0	1	0	0	0	1
13	1	1	0	0	❶+❸+❹	0	1	0	0	1	0
14	1	1	0	1	❶+❷+❹	1	0	0	0	0	1
15	1	1	1	0	❷+❸+❹	1	0	0	0	1	0
16	1	1	1	1	❶+❷+❸+❹	0	0	0	0	0	0

- **<u>Task 2: Sum-of-Minterms:</u>**

1. **CW=**
   Groupings:
   $\bar{A}B\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D} + AB\bar{C}D + ABC\bar{D}$

2. **ACW=**
   $\bar{A}\bar{B}C\bar{D} + \bar{A}BCD + A\bar{B}\bar{C}D + A\bar{B}CD + AB\bar{C}\bar{D}$

3. **L=**
   $\bar{A}\bar{B}\bar{C}D + \bar{A}BCD + A\bar{B}\bar{C}\bar{D}$

4. **R=**
   $\bar{A}\bar{B}CD + A\bar{B}\bar{C}D + A\bar{B}C\bar{D}$

5. **U=**
   $\bar{A}BC\bar{D} + AB\bar{C}\bar{D} + ABC\bar{D}$

6. **D=**
   $\bar{A}B\bar{C}D + A\bar{B}CD + AB\bar{C}D$

- **Simplify CW:**

$\bar{A}B\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D} + AB\bar{C}D + ABC\bar{D}$

Distributive law:

$A \cdot \bar{D} \cdot \bar{B} \cdot (\bar{C} + C) + \bar{A} \cdot B \cdot \bar{C} \cdot \bar{D} + A \cdot B \cdot \bar{C} \cdot D + A \cdot B \cdot C \cdot \bar{D}$

Complement law

$(1) \cdot (A \cdot \bar{D} \cdot \bar{B}) + \bar{A} \cdot B \cdot \bar{C} \cdot \bar{D} + A \cdot B \cdot \bar{C} \cdot D + A \cdot B \cdot C \cdot \bar{D}$

Identity law

$A \cdot \bar{D} \cdot \bar{B} + \bar{A} \cdot B \cdot \bar{C} \cdot \bar{D} + A \cdot B \cdot \bar{C} \cdot D + A \cdot B \cdot C \cdot \bar{D}$

Distributive law

$A \cdot \bar{D} \cdot (\bar{B} + B \cdot C) + \bar{A} \cdot B \cdot \bar{C} \cdot \bar{D} + A \cdot B \cdot \bar{C} \cdot D$

$(\bar{B} + B \cdot C) \cdot (A \cdot \bar{D}) + \bar{A} \cdot B \cdot \bar{C} \cdot \bar{D} + A \cdot B \cdot \bar{C} \cdot D$

Distributive law

$\left((\bar{B} + B) \cdot (\bar{B} + C)\right) \cdot (A \cdot \bar{D}) + \bar{A} \cdot B \cdot \bar{C} \cdot \bar{D} + A \cdot B.\bar{C} \cdot D$

Complement law

$\left(1 \cdot (\bar{B} + C)\right) \cdot (A \cdot \bar{D}) + \bar{A} \cdot B \cdot \bar{C} \cdot \bar{D} + A \cdot B \cdot \bar{C} \cdot D$

Identity law

$(\bar{B} + C) \cdot (A \cdot \bar{D}) + \bar{A} \cdot B \cdot \bar{C} \cdot \bar{D} + A \cdot B \cdot \bar{C} \cdot D$

Distributive law

$\bar{B} \cdot A \cdot \bar{D} + C \cdot A \cdot \bar{D} + \bar{A} \cdot B \cdot \bar{C} \cdot \bar{D} + A \cdot B \cdot \bar{C} \cdot D$

Answer

$\bar{B}A\bar{D} + CA\bar{D} + \bar{A}B\bar{C}\bar{D} + AB\bar{C}D$

- **Karnaugh Map (K-Map)**

AB \ CD	00	01	11	10
00	0	0	0	0
01	1	0	0	0
11	0	1	0	1
10	1	0	0	1

First: Grouping (01,00) +(11,01) +(11,10) +(10,00) +(10,10)

$$\therefore = (\overline{A}\cdot B\cdot \overline{C}\cdot \overline{D}) + (A\cdot B\cdot \overline{C}\cdot D) + (A\cdot B\cdot C\cdot \overline{D}) + (A\cdot \overline{B}\cdot \overline{C}\cdot \overline{D}) + (A\cdot \overline{B}\cdot C\cdot \overline{D})$$

For these 3 terms $(A\cdot B\cdot C\cdot \overline{D}) + (A\cdot \overline{B}\cdot \overline{C}\cdot \overline{D}) + (A\cdot \overline{B}\cdot C\cdot \overline{D})$ *is not simplified, so I will simplify it:*

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

Distributive law

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

Complement law

$(1)\cdot (A\cdot C\cdot \overline{D}) + A\cdot \overline{B}\cdot \overline{C}\cdot \overline{D}$

Identity law

$A\cdot C\cdot \overline{D} + A\cdot \overline{B}\cdot \overline{C}\cdot \overline{D}$

Distributive law

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

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

Distributive law

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

Complement law

$(1\cdot (C + \overline{B}))\cdot (A\cdot \overline{D})$

Identity law

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

Distributive law

$C\cdot A\cdot \overline{D} + \overline{B}\cdot A\cdot \overline{D}$

Answer

$C \cdot A \cdot \overline{D} + \overline{B} \cdot A \cdot \overline{D}$

$\because \left(A \cdot B \cdot C \cdot \overline{D}\right) + \left(A \cdot \overline{B} \cdot \overline{C} \cdot \overline{D}\right) + \left(A \cdot \overline{B} \cdot C \cdot \overline{D}\right) = C \cdot A \cdot \overline{D} + \overline{B} \cdot A \cdot \overline{D}$

$\therefore$ *last question will be:*

$$\overline{B} \cdot A \cdot \overline{D} + C \cdot A \cdot \overline{D} + \overline{A} \cdot B \cdot \overline{C} \cdot \overline{D} + A \cdot B \cdot \overline{C} \cdot D$$

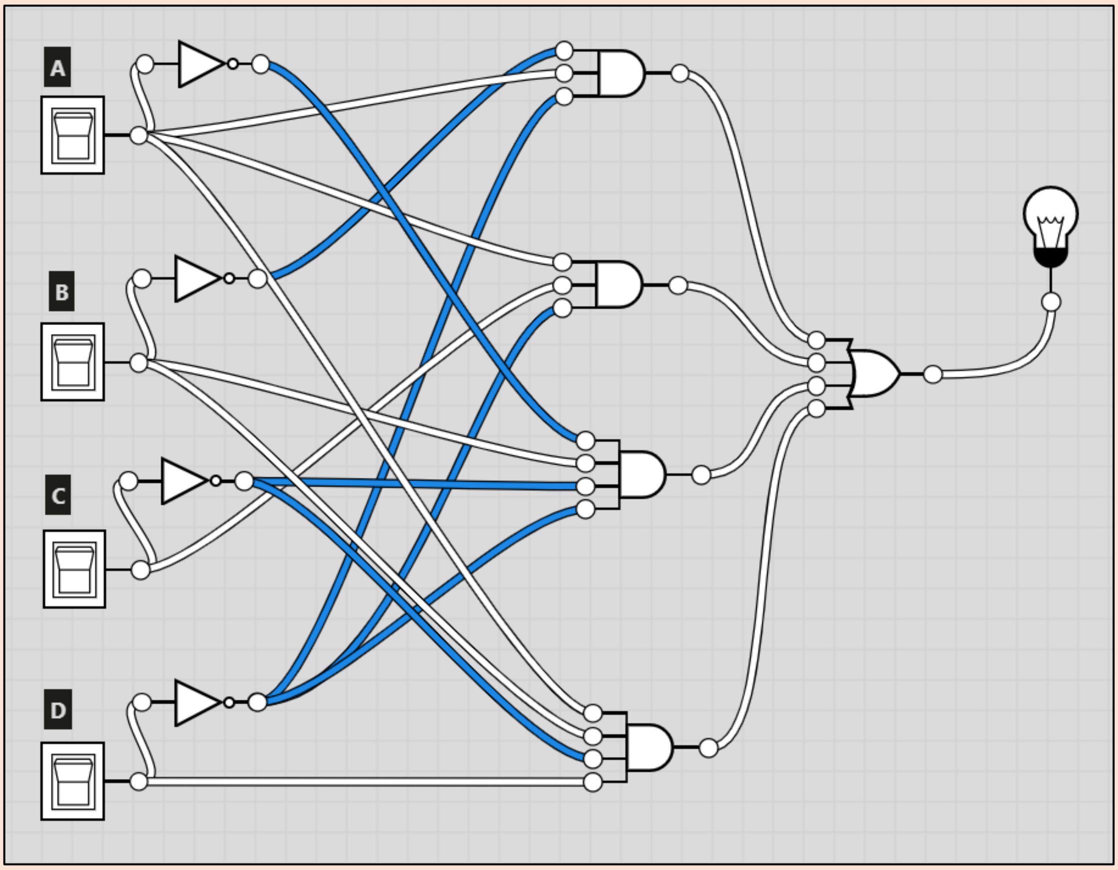
OR

$$\overline{B}A\overline{D} + CA\overline{D} + \overline{A}B\overline{C}\overline{D} + AB\overline{C}D$$

Simplify CW = Karnaugh Map (K-Map) ⋕

- **<u>Task 3: Draw the circuit for simplified CW logic/expression</u>**

$$\overline{B}A\overline{D} + CA\overline{D} + \overline{A}B\overline{C}\overline{D} + AB\overline{C}D$$

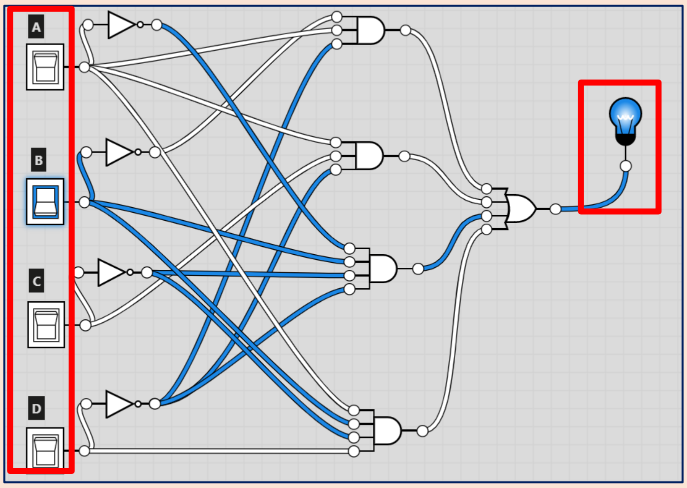


To make sure of this circuit, I will apply the binary numbers in the previous table, which are:

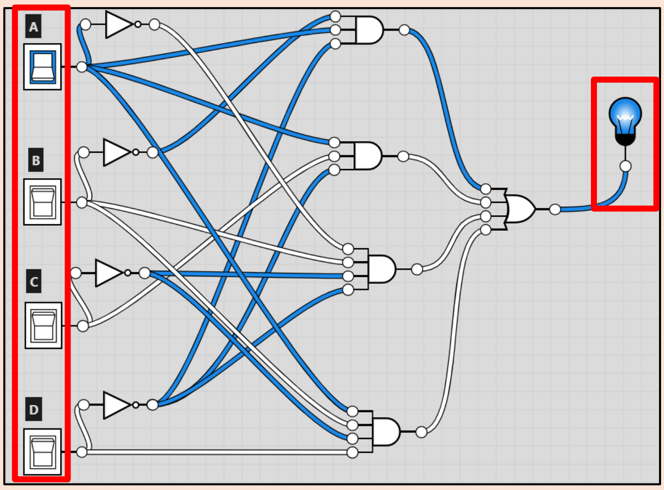
A	B	C	D	CW
0	1	0	0	1
1	0	0	0	1
1	0	1	0	1
1	1	0	1	1
1	1	1	0	1

The circuit should light up.

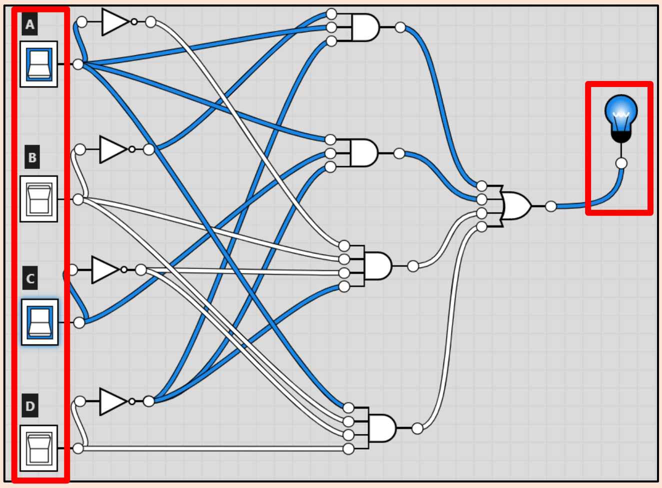
a. 0100:



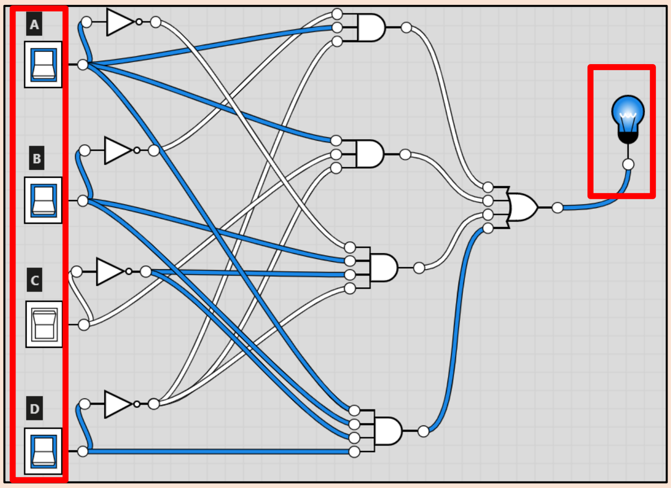
b. 1000:



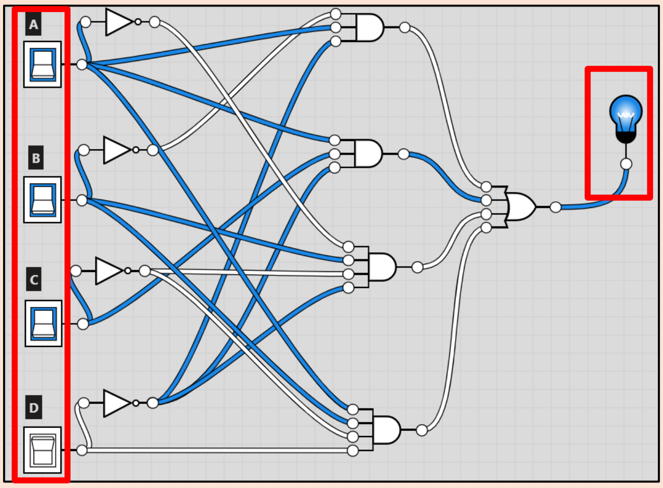
c. 1010:



d. 1101:



e. 1110



- **<u>Task 4: Convert the CW expression to use NAND gates only</u>**

$$\bar{B}\cdot A\cdot\bar{D} + C\cdot A\cdot\bar{D} + \bar{A}\cdot B\cdot\bar{C}\cdot\bar{D} + A\cdot B\cdot\bar{C}\cdot D$$

Double complement

$$\overline{\overline{\bar{B}\cdot A\cdot\bar{D} + C\cdot A\cdot\bar{D} + \bar{A}\cdot B\cdot\bar{C}\cdot\bar{D} + A\cdot B\cdot\bar{C}\cdot D}}$$

$$\overline{\overline{\bar{B}\cdot A\cdot\bar{D}}\cdot\overline{C\cdot A\cdot\bar{D}}\cdot\overline{\bar{A}\cdot B\cdot\bar{C}\cdot\bar{D}}\cdot\overline{A\cdot B\cdot\bar{C}\cdot D}}$$

$$\overline{\overline{\bar{B}A\bar{D}}\cdot\overline{CA\bar{D}}\cdot\overline{\bar{A}B\bar{C}\bar{D}}\cdot\overline{AB\bar{C}D}}$$

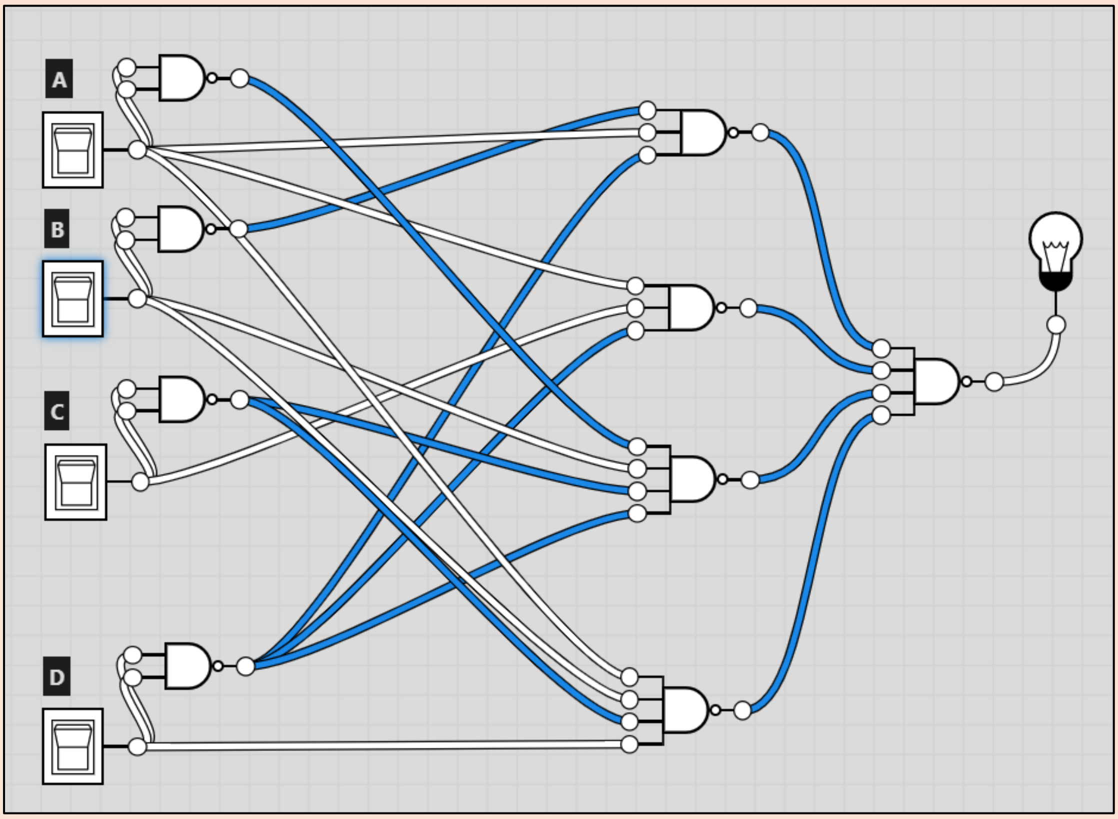
- **<u>Task 5: Demonstrate that the NAND version of CW is correct</u>**

Column number				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	B	C	D	CW	$\bar{A}$	$\bar{B}$	$\bar{C}$	$\bar{D}$	$\bar{B}A\bar{D}$	$\overline{\bar{B}A\bar{D}}$	$CA\bar{D}$	$\overline{CA\bar{D}}$	$\bar{A}B\bar{C}\bar{D}$	$\overline{\bar{A}B\bar{C}\bar{D}}$	$AB\bar{C}D$	$\overline{AB\bar{C}D}$	$\overline{\bar{B}A\bar{D}}\cdot\overline{CA\bar{D}}\cdot\overline{\bar{A}B\bar{C}\bar{D}}\cdot\overline{AB\bar{C}D}$	$\overline{\overline{\bar{B}A\bar{D}}\cdot\overline{CA\bar{D}}\cdot\overline{\bar{A}B\bar{C}\bar{D}}\cdot\overline{AB\bar{C}D}}$
0	1	0	0	1	1	0	1	1	0	1	0	1	1	0	0	1	0	1
1	0	0	0	1	0	1	1	1	1	0	0	1	0	1	0	1	0	1
1	0	1	0	1	0	1	0	1	1	0	0	1	0	1	0	1	0	1
1	1	0	1	1	0	0	1	0	0	1	0	1	0	1	1	0	0	1
1	1	1	0	1	0	0	0	1	0	1	1	0	0	1	0	1	0	1

Equal

- **<u>Task6: Draw the NAND-only version of the CW circuit</u>**

$$\overline{\overline{\overline{B}A\overline{D}} \cdot \overline{CA\overline{D}} \cdot \overline{\overline{A}B\overline{C}\overline{D}} \cdot \overline{AB\overline{C}D}}$$

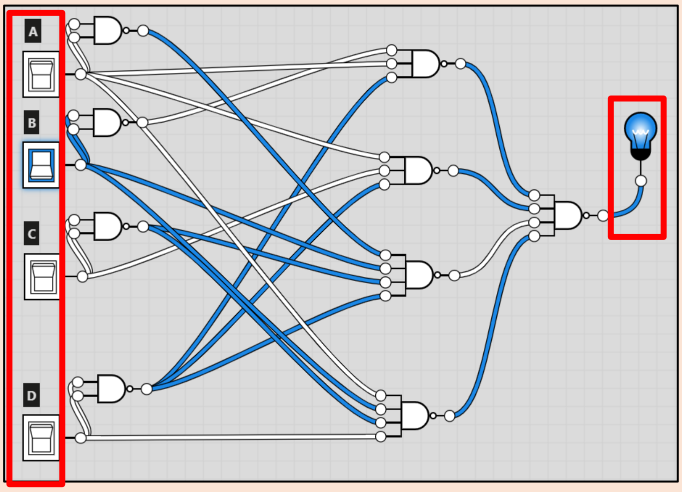


To make sure of this circuit, I will apply the binary numbers in the previous table, which are:

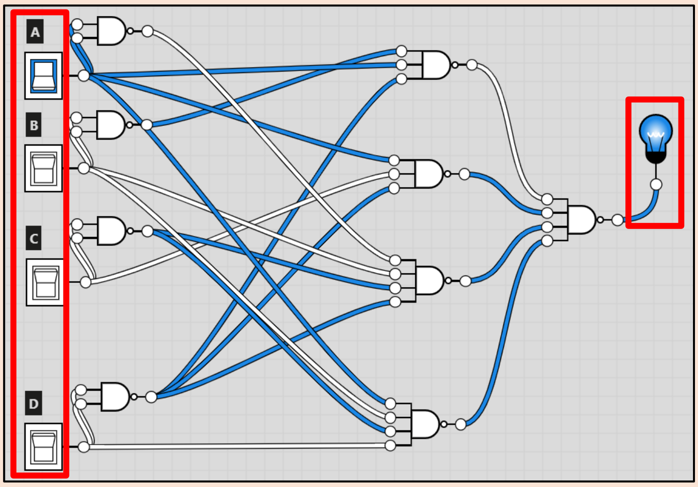
A	B	C	D	CW
0	1	0	0	1
1	0	0	0	1
1	0	1	0	1
1	1	0	1	1
1	1	1	0	1

The circuit should light up.

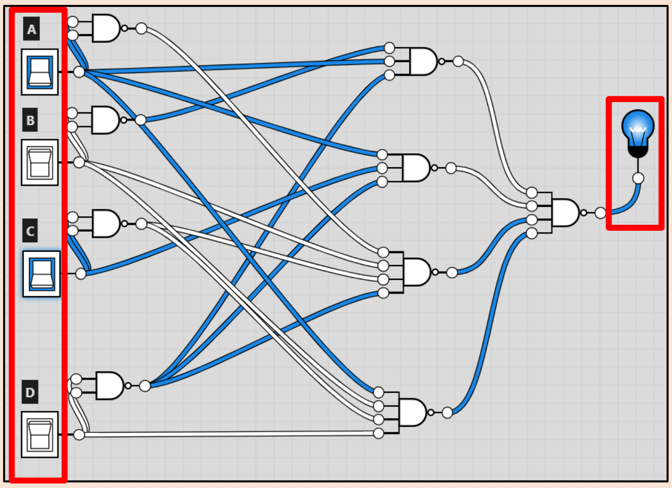
a. 0100



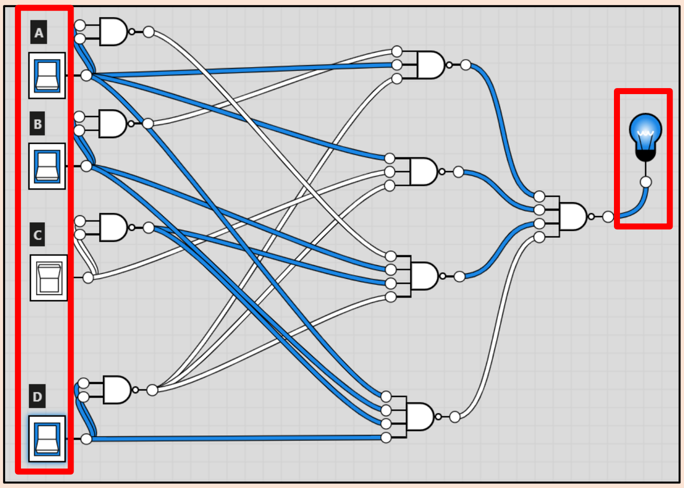
b. 1000



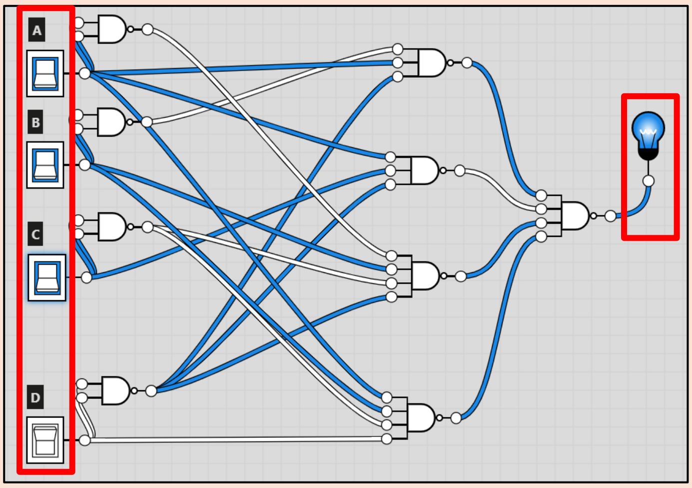
c. 1010



d. 1101



e. 1110



<u>Conclusion</u>:

By observing the "Truth table" in the top, we can notice that a person when using this device can control in all directions by pressing the buttons differently, and individually, and at the same moment on the control bar the person can move with or against the clock direction, Thus, finally, a special console was designed for drunk game player.

End.