MULTIMEDIA UNIVERSITY

THIRD TRIMESTER, **SESSION 2019/2020**

ASSIGNMENT 1 (5%)

EEE1036 – DIGITAL LOGIC DESIGN

(All sections / Groups)

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Table of Contents

Implementing combinational & sequential circuits to build a Hospital Automatic Smart System

Introduction

In the 21st century we are using a lot of digital gadgets to make our life easier. Those things are fully made with Digital logic design. Digital logic design is a system in electrical and computer engineering that uses simple number values to produce input and output operations. As a digital design engineer, you may assist in developing cell phones, computers, and related personal electronic devices. We also find electronic components and circuits in every part of our life, from electric toothbrushes, to sophisticated super computers capable of simulating the universe for physicist.

In this report we will go through several steps of building a digital logic circuit based on what we learnt in EEE1036, gain experience of hardware construction and design system using sequential or combinational logic using simulation tools as well as apply the concepts of sequential logic and memory devices in digital systems. Apart from that, the appreciation of the teamwork and project management skills, and also to appreciate the nature of systems design.

The topic of the assignment is "**Hospital Automatic Smart System -Simulation**". We are also allowed to use Sequential and Combinational circuits, flip flop counters. To get the output, we are using a truth table, K-map, state diagram, state table, logic circuit diagram. To design and concept systems for sequential or combinational logic in digital systems and applying the concepts of sequential logic and memory devices in digital systems.

To implement these applications of these digital logic circuits, this report will examine a situation related to Automatic Smart ON/OFF systems. An individual has set an Automatic Smart control system where this circuit can be used as a power saving circuit. This system automatically counts the maximum person entering the room which we set to be **fifteen**. The system will automatically switch off the lights, air conditioner when the hospital laboratory is empty. The sequence of input values will be the counts of the person who enters the hospital laboratory and the outputs are indicated lights, fans, air conditioners are on/off.

Requirement:

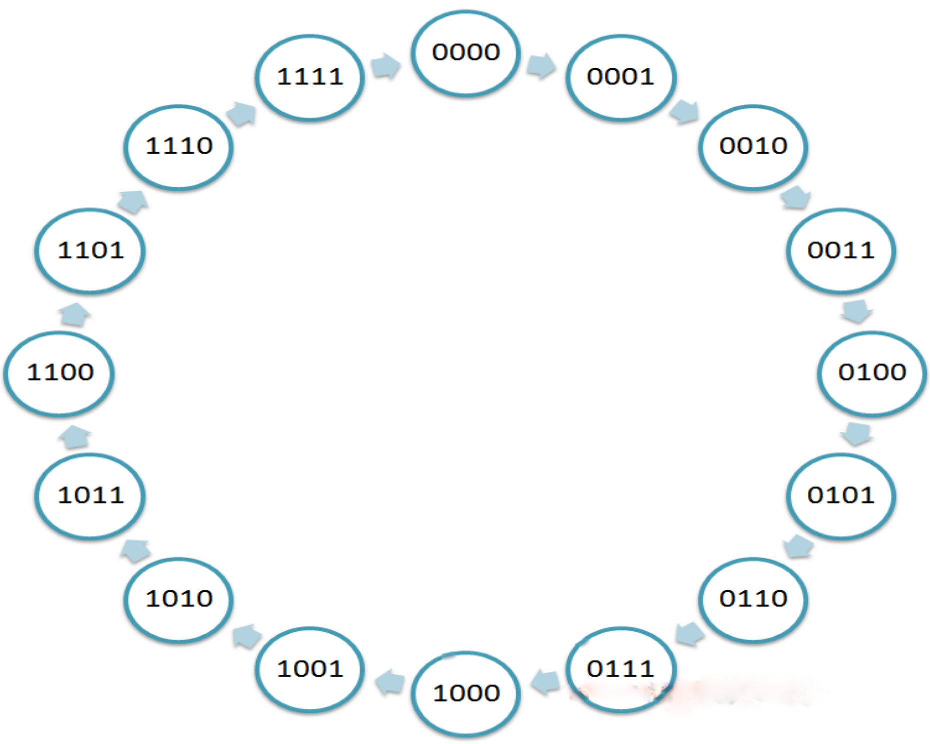
For implementing this circuit, we require:

- 4-bit asynchronous counter
- T-flip flop
- LED
- AND and OR Gates

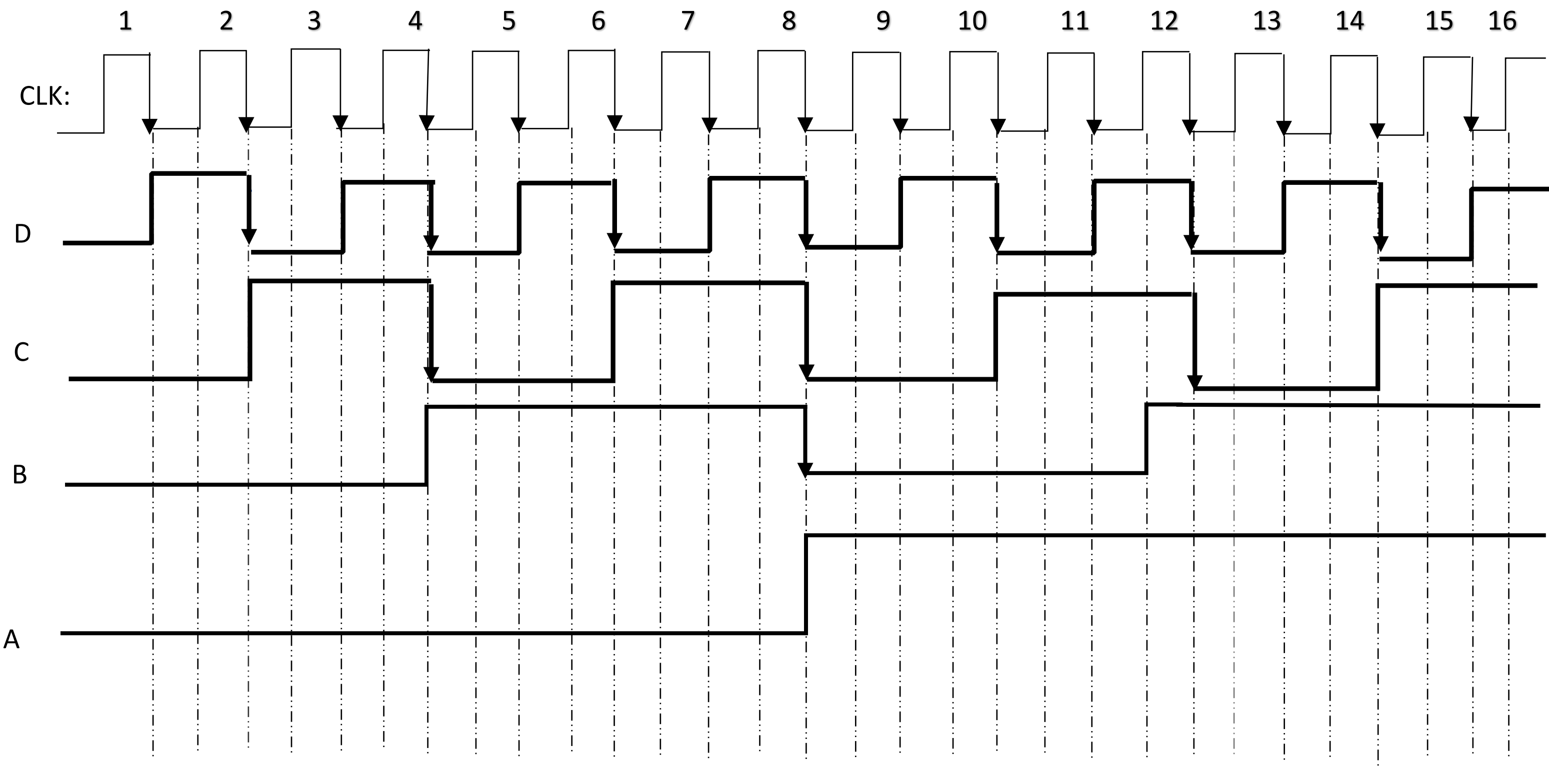
Before we start the demonstration of our project, we would like to grab the chance to thank our respected teachers. We really appreciate their support. They have provided valuable information and morale to complete this research and report.

The System Design

The State Diagram:First of all, we start by detecting the problem given and transfer the important information into steps. The system will count the person who enter the room which we set it to be maximum for **fifteen** people. Our system starts counting from 0 $(0000)_2$ to until 15 $(1111)_2$.



Timing diagram:



The State table:

State table for Counter:

From the state diagram above, since we are dealing with 4-bits, we will be needing 4 flip flops (T-flip flop for this task. Initially, all the flip flops have an output of 0 so, in order for us to make a counter using the flip flops, we need to have an input for each flip flop to get the required counter. For our circuit we use **negative edge trigger** T-flip flop.

CLK Pulse	Output				Decimal Number
	A(Q_A)	B(Q_B)	C (Q_C)	D(Q_D)	
Initial	0	0	0	0	0
1st	0	0	0	1	1
2nd	0	0	1	0	2
3rd	0	0	1	1	3
4th	0	1	0	0	4
6th	0	1	0	1	5
7th	0	1	1	0	6
8th	0	1	1	1	7
9th	1	0	0	0	8
10th	1	0	0	1	9
11th	1	0	1	0	10
12th	1	0	1	1	11
13th	1	1	0	0	12
14th	1	1	0	1	13
15th	1	1	1	0	14
16th	1	1	1	1	15

The Truth Table:

- From the state table, now we can proceed to the truth table. We just have 16 inputs because we consider maximum number of people to enter the room is 16.
- And throughout this input, there are three things we have to look which are the lights, fan and air conditioner whether it switch on or off. For switch on we consider it as 1 and switch off we consider as 0.
- For turning on and off we use condition which is, when nobody inside the room all the fans, lights and air conditions are turned off.
  When more than 4 persons enter the then air conditioner automatically turned on and fan automatically turned off. Again, if less than or equal 4 persons then air conditioner automatically turned off and fan automatically turned on.
  In brief,
  Number of people inside the room ≤ 4 persons Fans are ON, Air Conditioners are OFF
  Number of people inside the room > 4 persons in the room Fans are OFF, Air Conditioners are ON

- So, based on the inputs and the conditions of the output above we construct the truth table as below:

Truth table

Decimal Number	A	B	C	D	Light Sensor	Fan Sensor	Air Condition Sensor
0	0	0	0	0	0	0	0
1	0	0	0	1	1	1	0
2	0	0	1	0	1	1	0
3	0	0	1	1	1	1	0
4	0	1	0	0	1	1	0
5	0	1	0	1	1	0	1
6	0	1	1	0	1	0	1
7	0	1	1	1	1	0	1
8	1	0	0	0	1	0	1
9	1	0	0	1	1	0	1
10	1	0	1	0	1	0	1
11	1	0	1	1	1	0	1
12	1	1	0	0	1	0	1
13	1	1	0	1	1	0	1
14	1	1	1	0	1	0	1
15	1	1	1	1	1	0	1

The Boolean Expressions from the Truth Table (SOP)

- Light sensor = $\bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + \bar{A}BCD + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}D + A\bar{B}C\bar{D} + A\bar{B}CD + AB\bar{C}\bar{D} + AB\bar{C}D + ABC\bar{D} + ABCD$

- Fan = $\bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D}$

- Air Condition=$\bar{A}B\bar{C}D + \bar{A}BC\bar{D} + \bar{A}BCD + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}D + A\bar{B}C\bar{D} + A\bar{B}CD + AB\bar{C}\bar{D} + AB\bar{C}D + ABC\bar{D} + ABCD$

K-Map:

The k-Maps for the 3 outputs using the obtained SOPs:

This step we make the K-map from the state table.

K-Map for Light sensor:

C D

A B

------	0 0	0 1	1 1	1 0
0 0	0	1	1	1
0 1	1	1	1	1
1 0	1	1	1	1
1 1	1	1	1	1

The obtained Equation from the K-Map:

Light Sensor= A+B+C+D

K-Map for Fan:

C D

A B

-------	0 0	0 1	1 1	1 0
0 0	0	1	1	1
0 1	1	0	0	0
1 1	0	0	0	0
1 0	0	0	0	0

The obtained Equation from the K-Map:

Fan=$\bar{A}\bar{B}D + \bar{A}\bar{B}C + \bar{A}B\bar{C}\bar{D}$

K-Map for Air Condition:

C D

A B

--------	0 0	0 1	1 1	1 0
0 0	0	0	0	0
0 1	1	1	1	1
1 1	1	1	1	1
1 0	0	1	1	1

The obtained Equation from the K-Map:

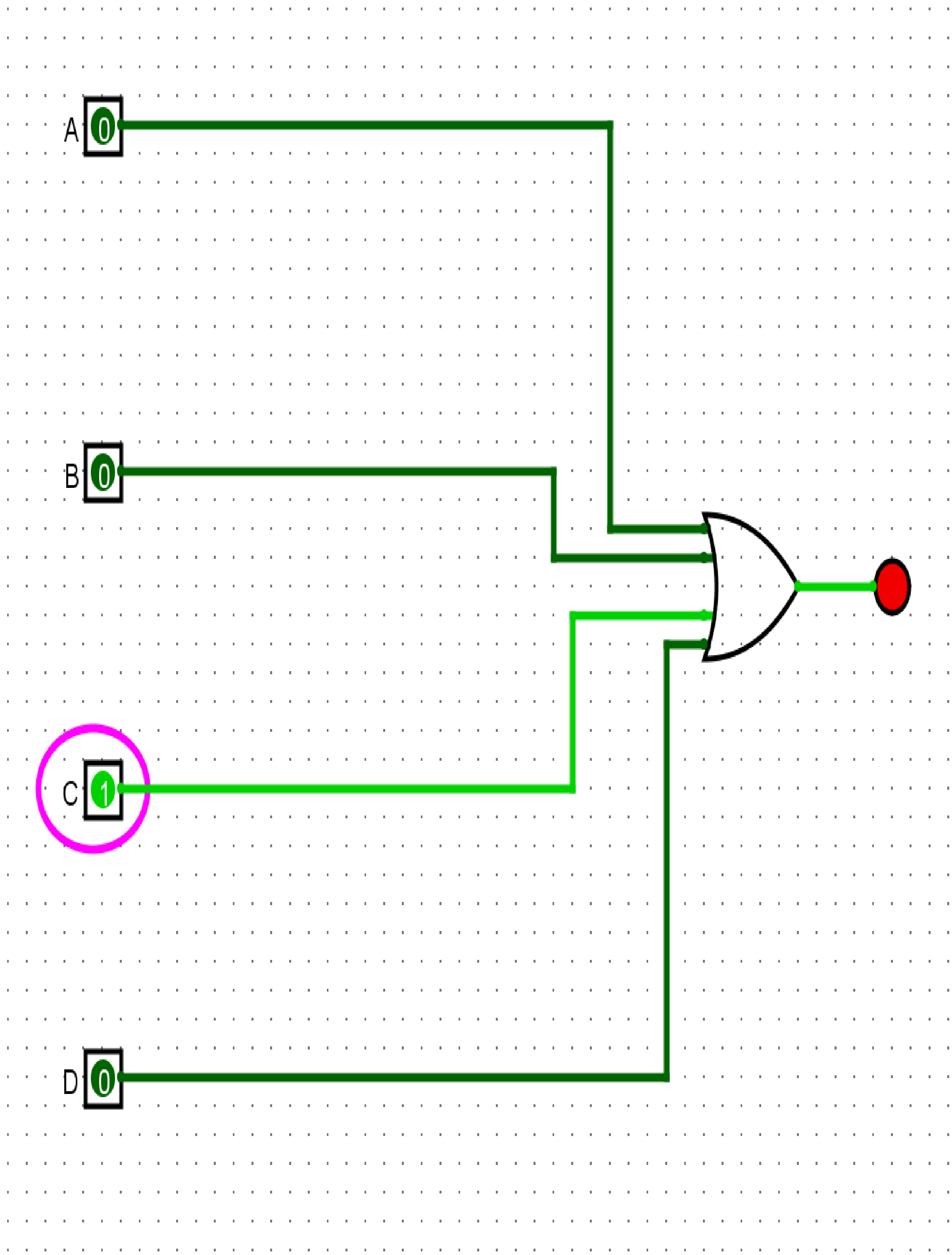
Air Condition= A + BD + BC.

=A+B(C+D)

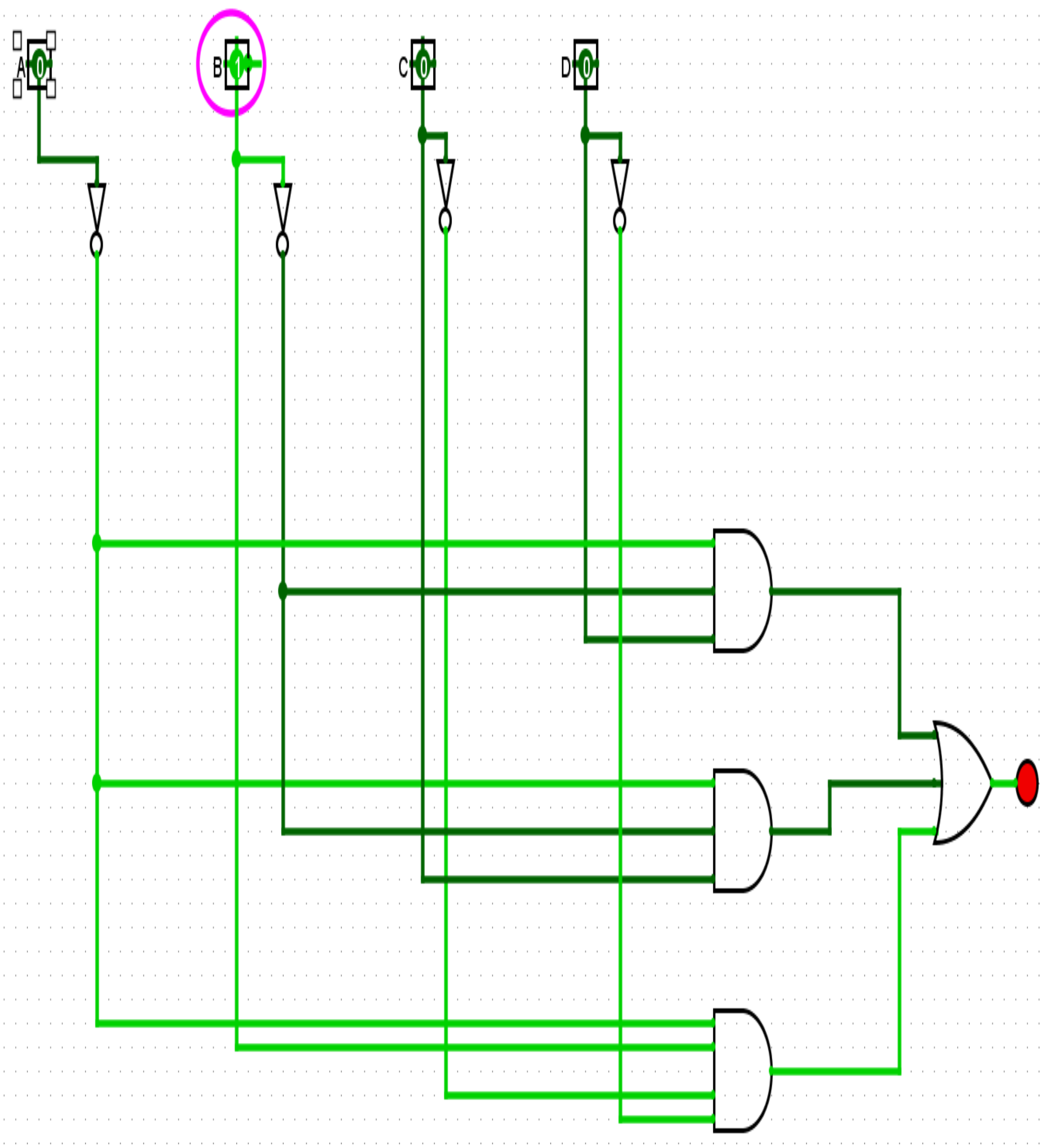
.

The Circuits Diagrams

Light Sensor= A+B+C+D

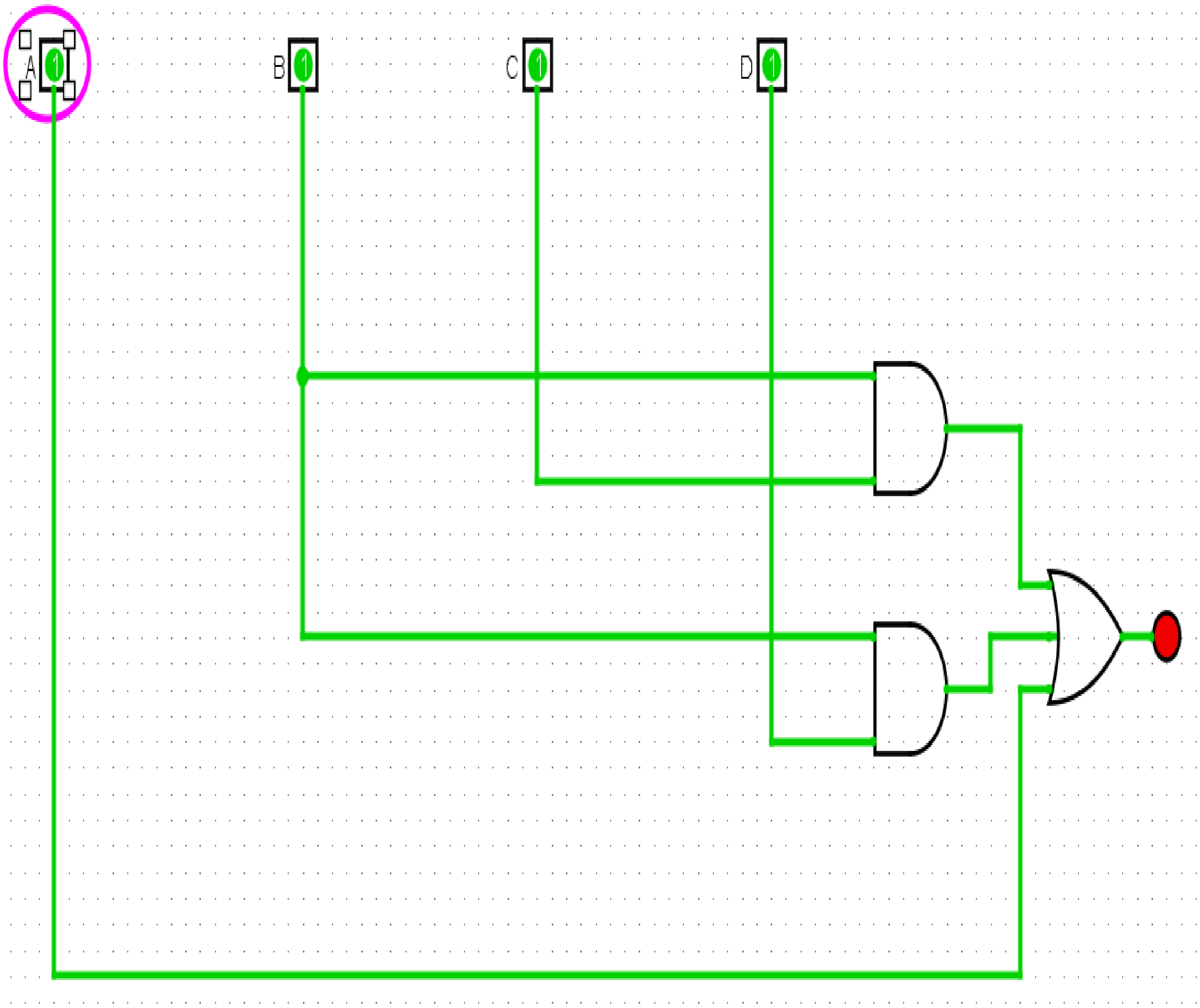


Fan=$\bar{A}\bar{B}D + \bar{A}\bar{B}C + \bar{A}B\bar{C}\bar{D}$



Air Condition= A + BD + BC.

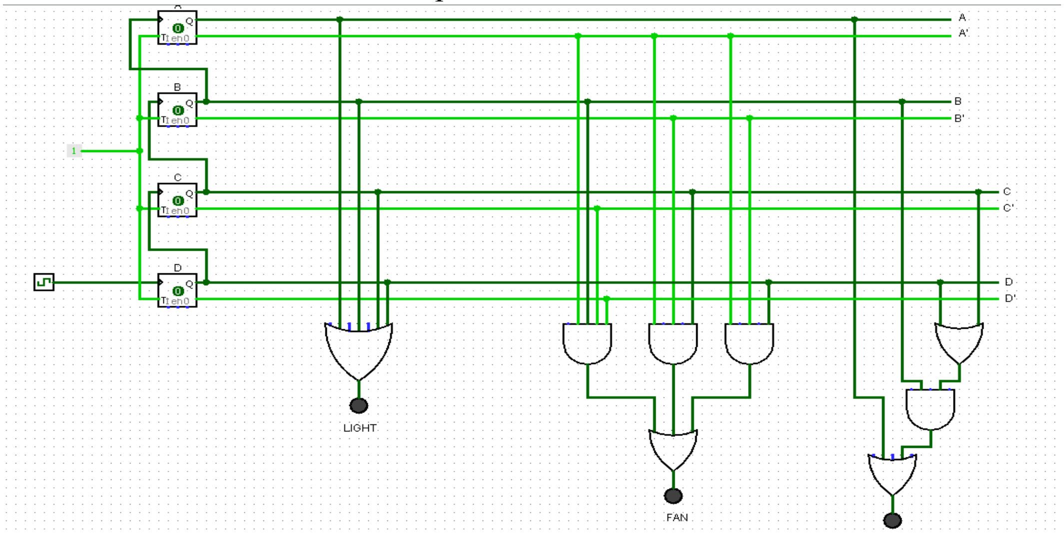
=A+B(C+D)



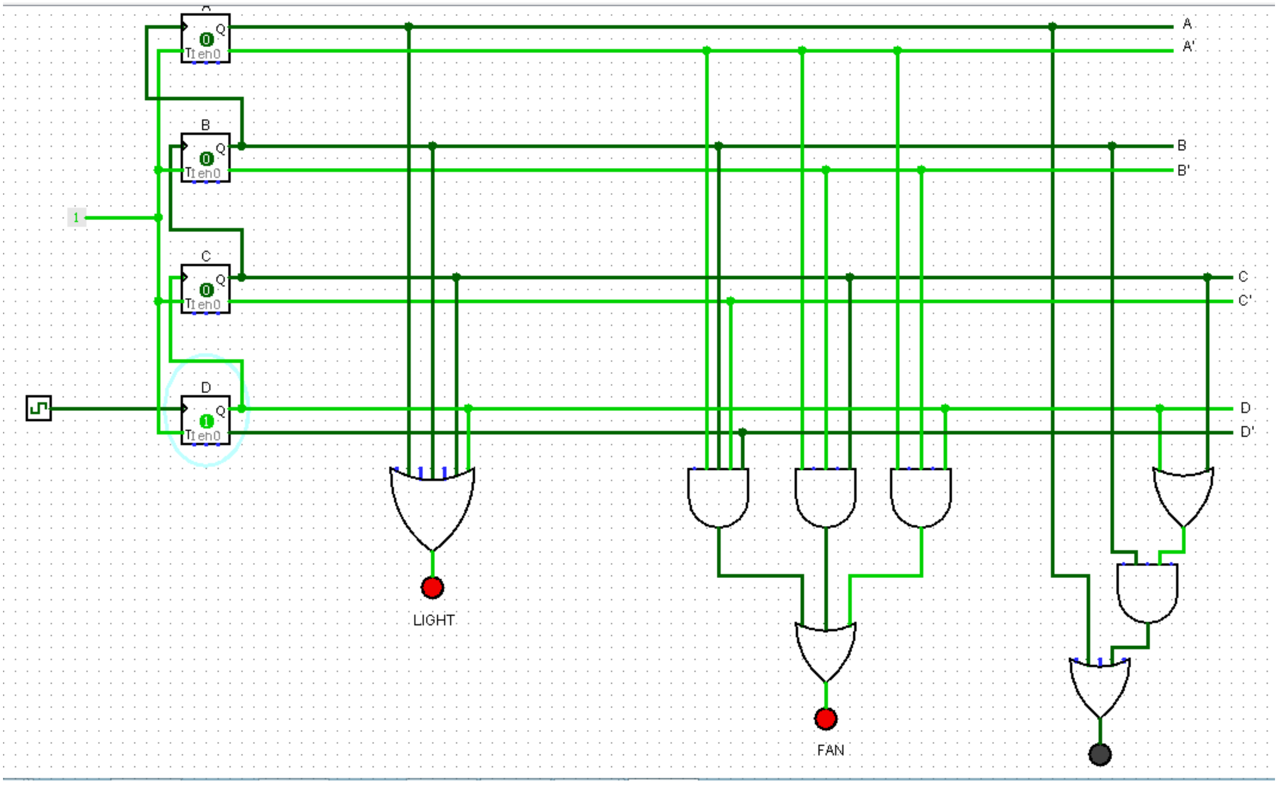
System Simulation and analysis:

System circuit Diagram: Upon completing previous steps, we gained all necessary information and instructions to design the logic circuit diagram. With the help of a software called 'LOGISIM', we managed to design and simulate the circuit. Below, we can see the circuit and its outcomes:

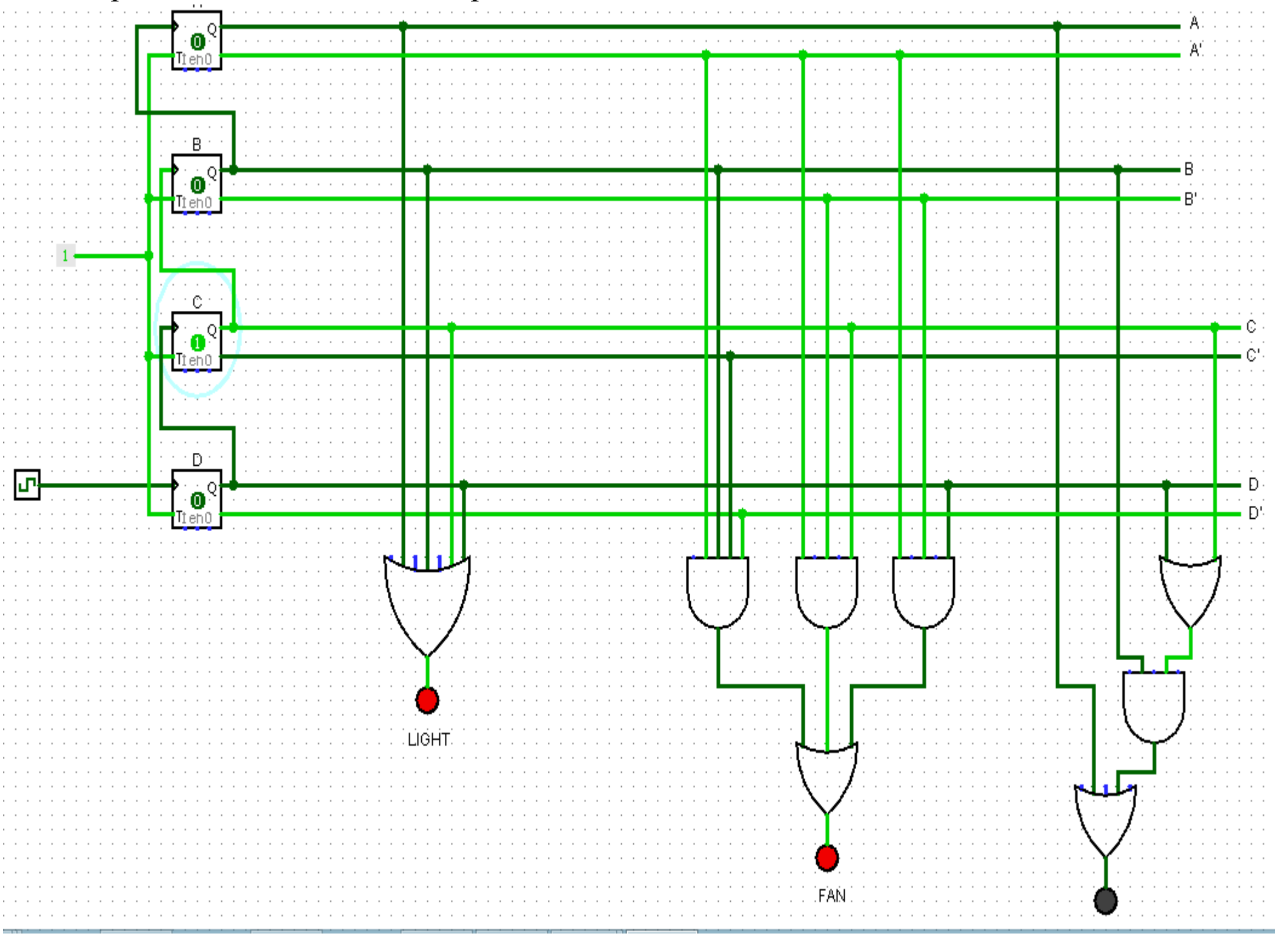
No one enter the room or when input 0000:



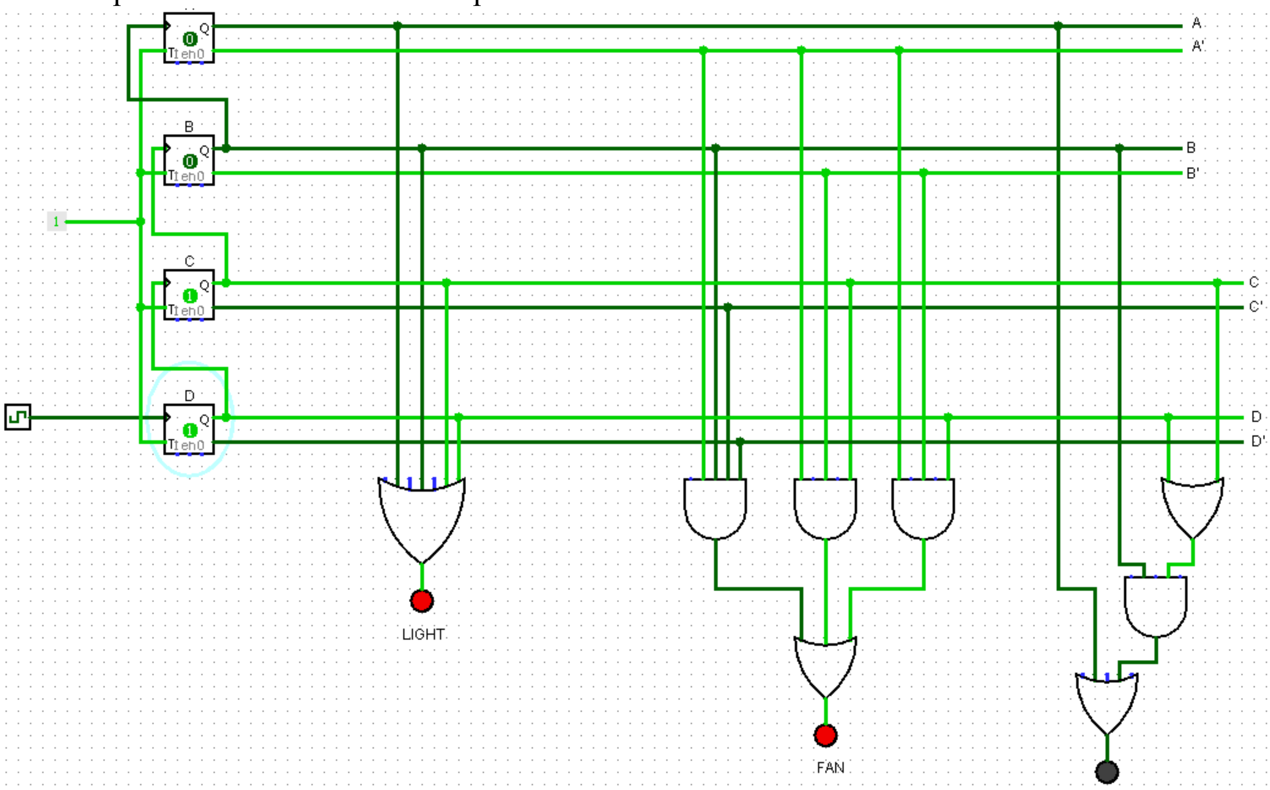
When only one person enter the room or input 0001:



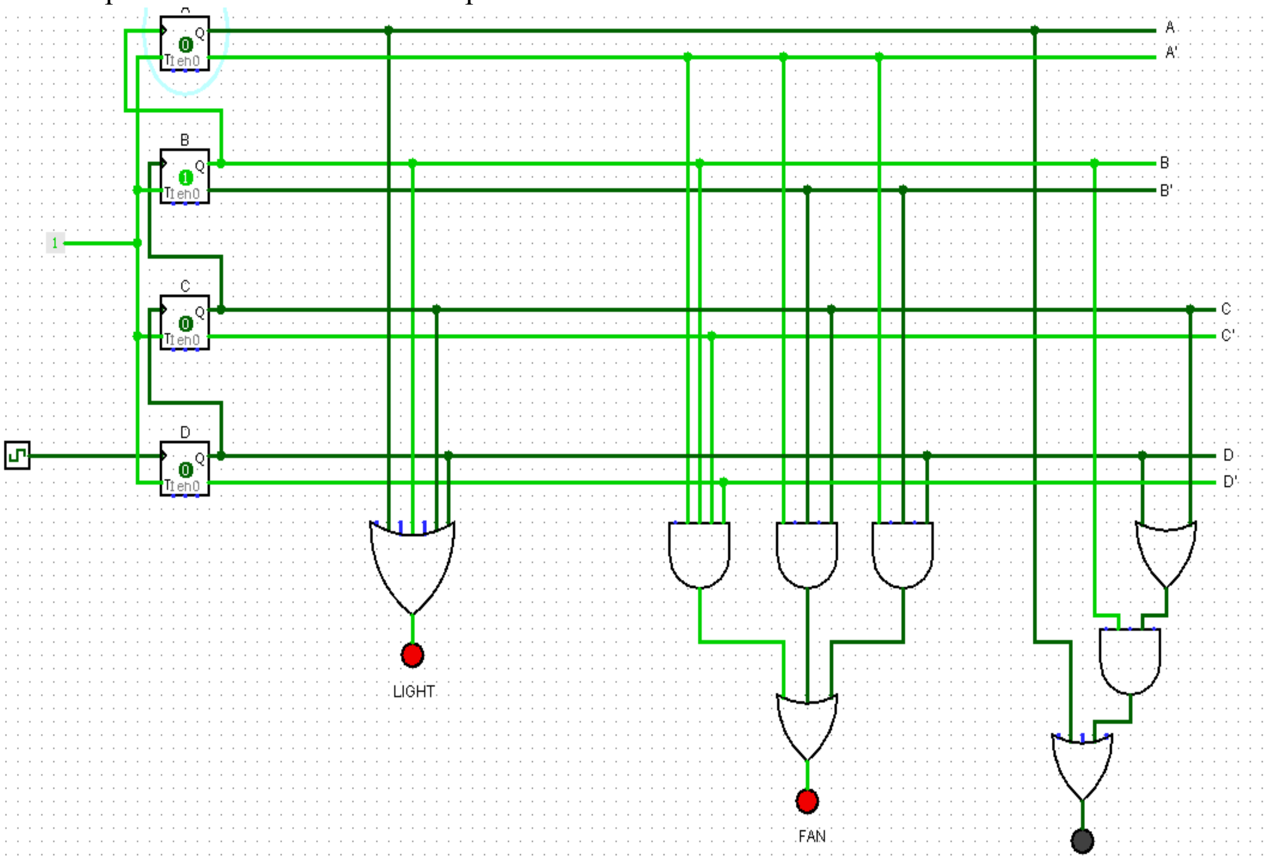
When 2 persons enter the room or input 0010:



When 3 persons enter the room or input 0011:

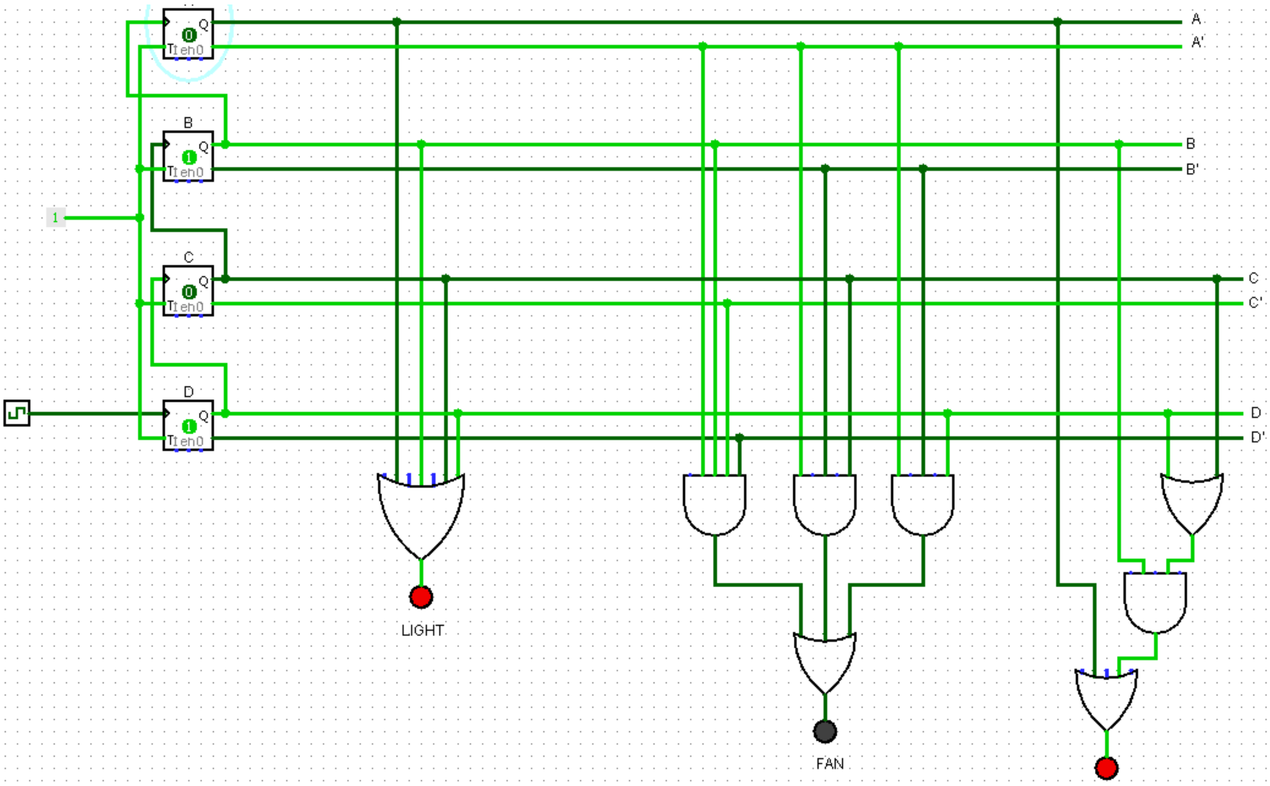


When 4 persons enter the room or input 0100:

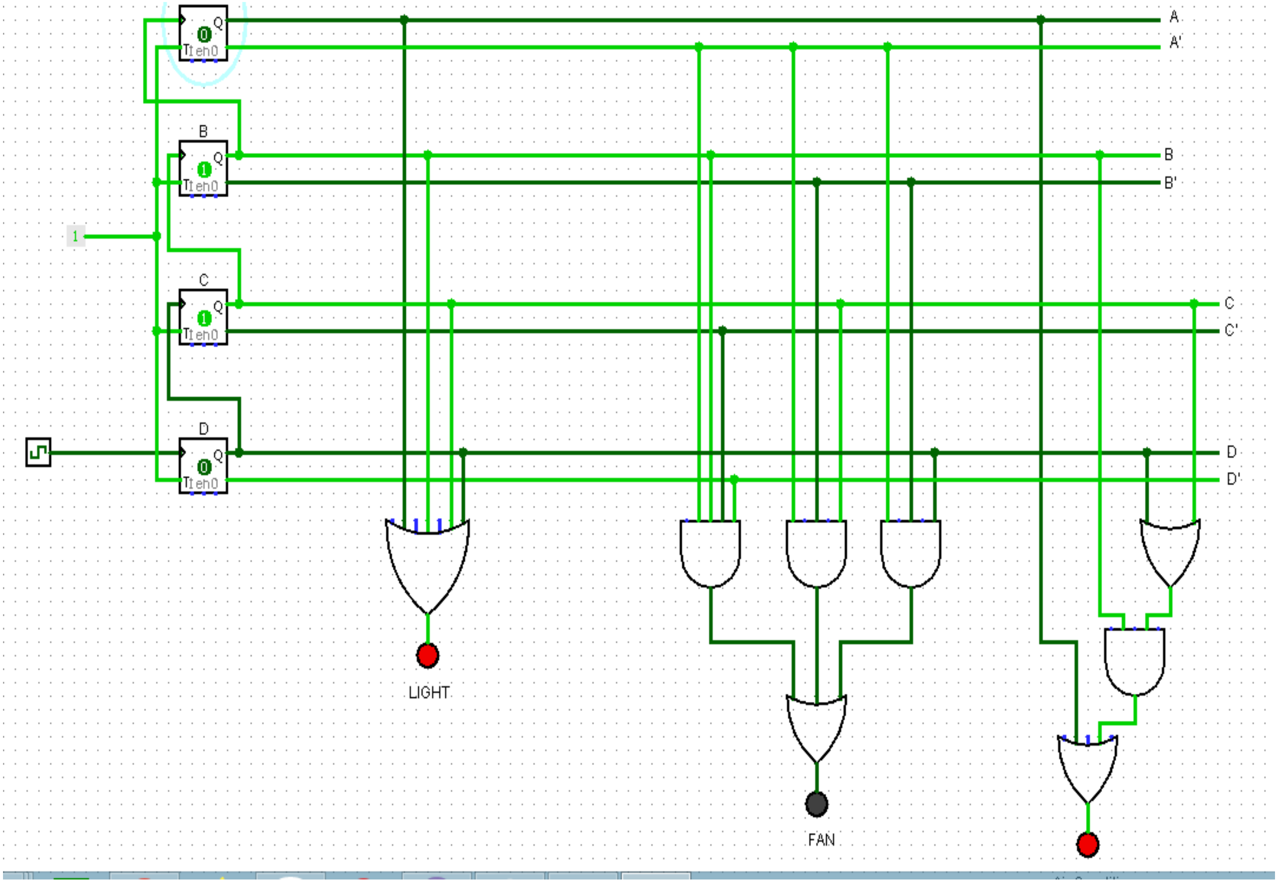


When 5 persons enter the room or input 0101:

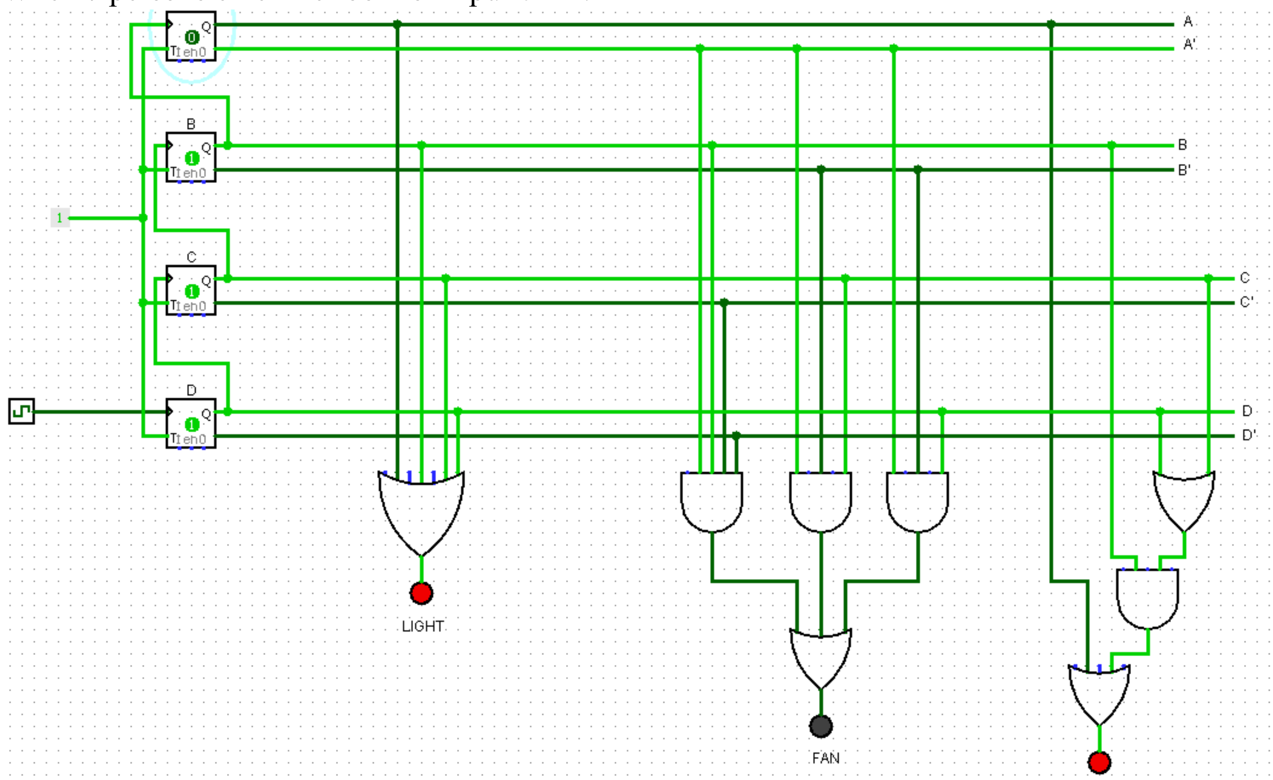
Here 5 persons enter the room so according to our condition fan trunned off and air conditioner trunned on.



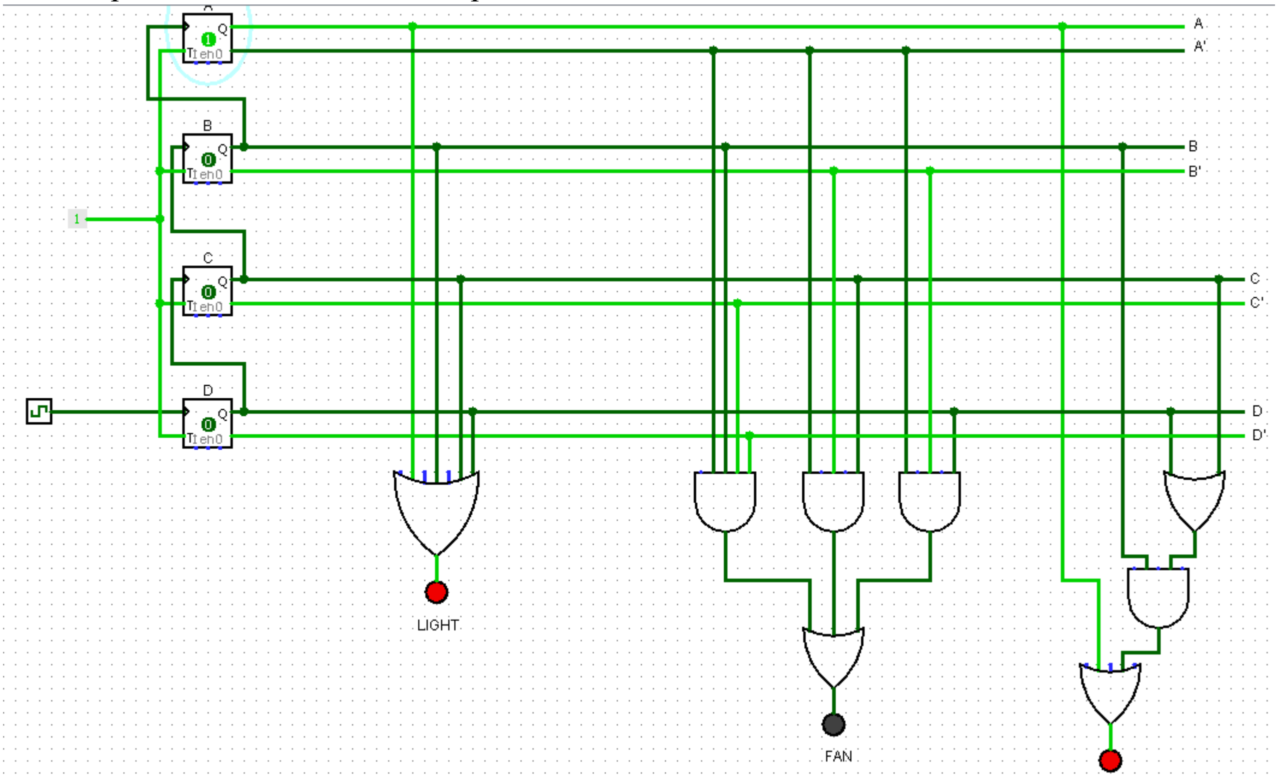
When 6 persons enter the room or input 0110:



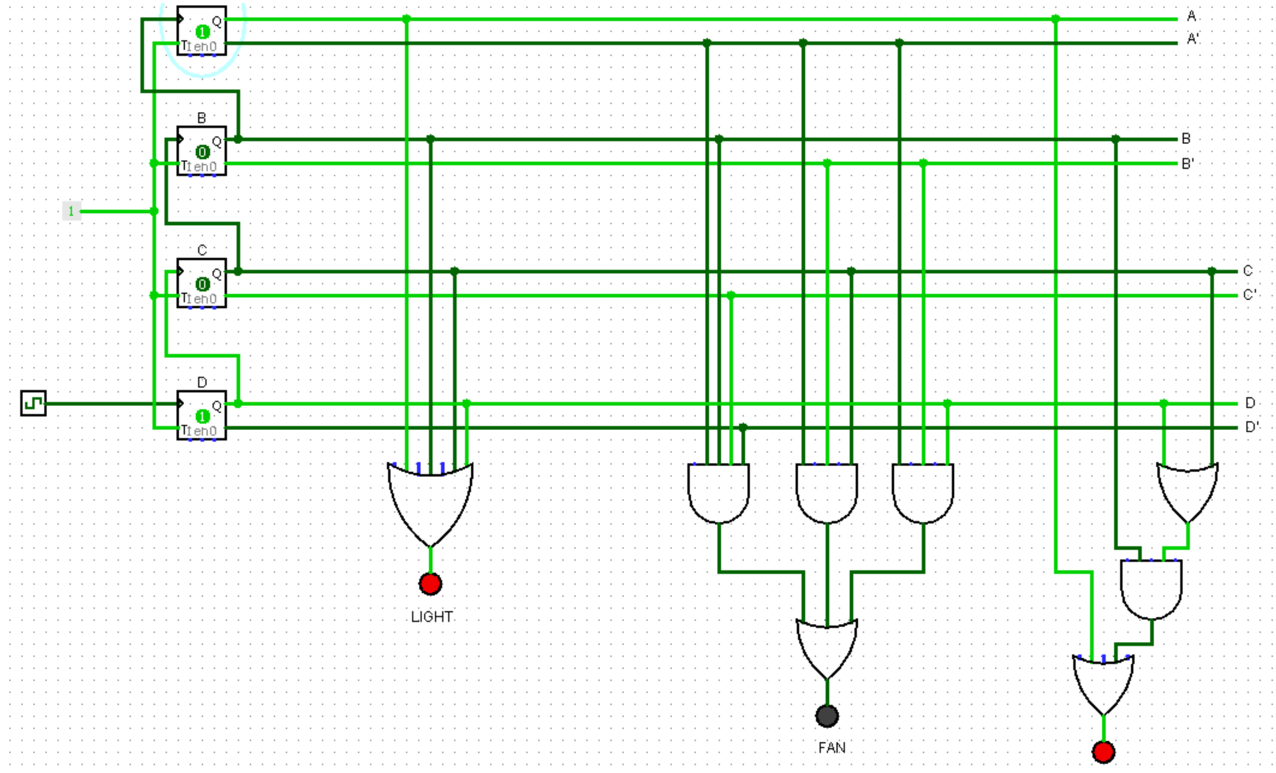
When 7 persons enter the room or input 0111:



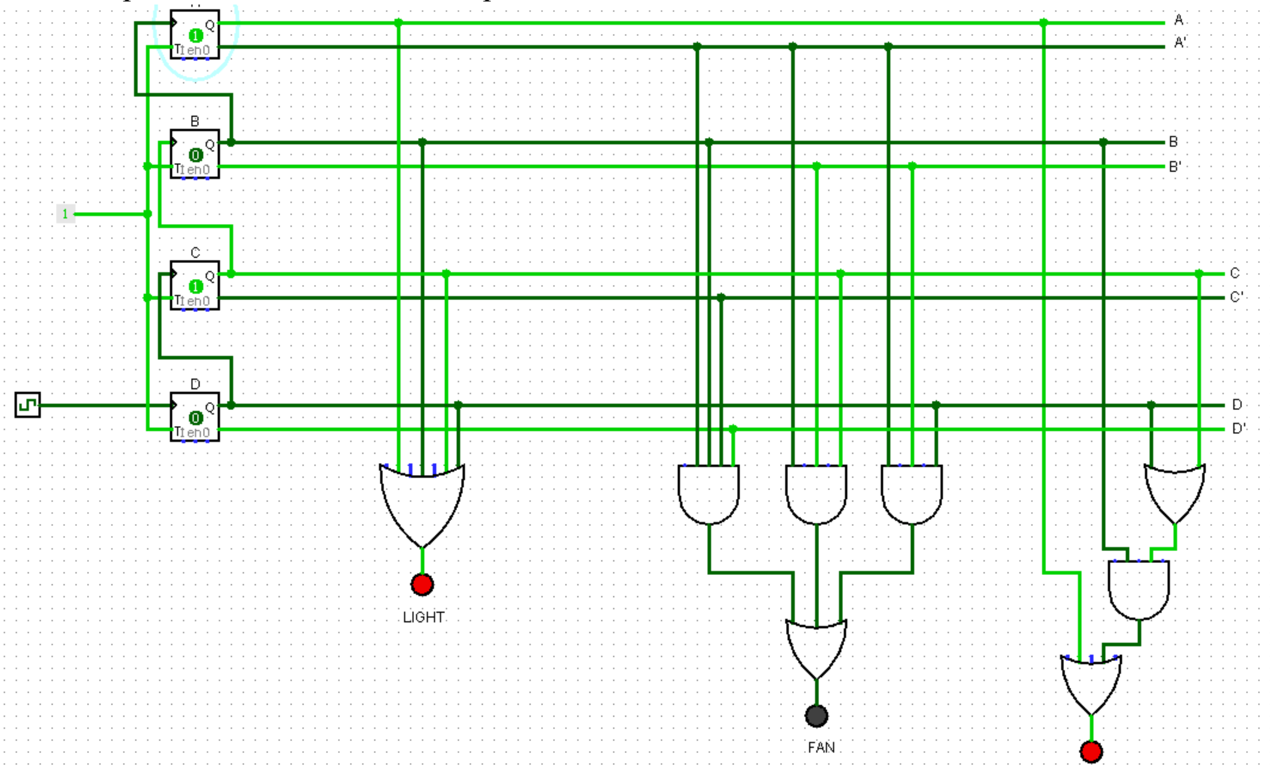
When 8 persons enter the room or input 1000:



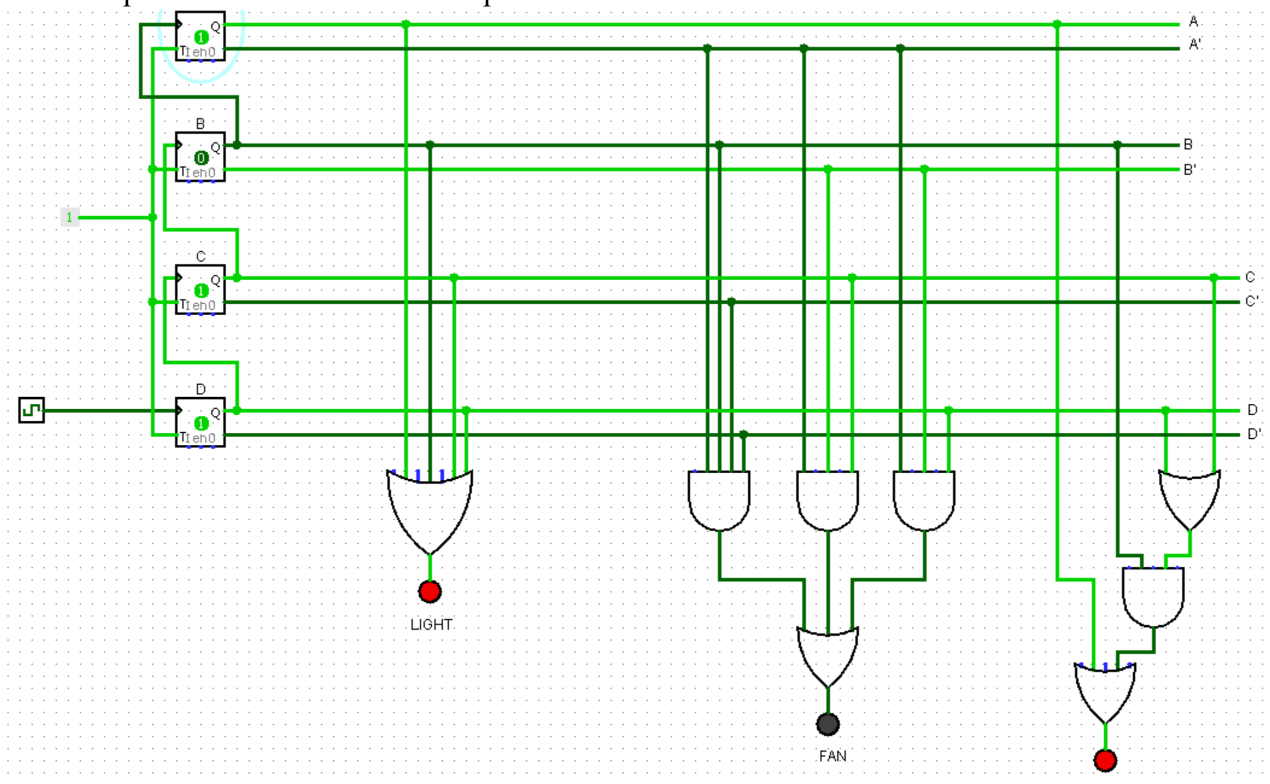
When 9 persons enter the room or input 1001:



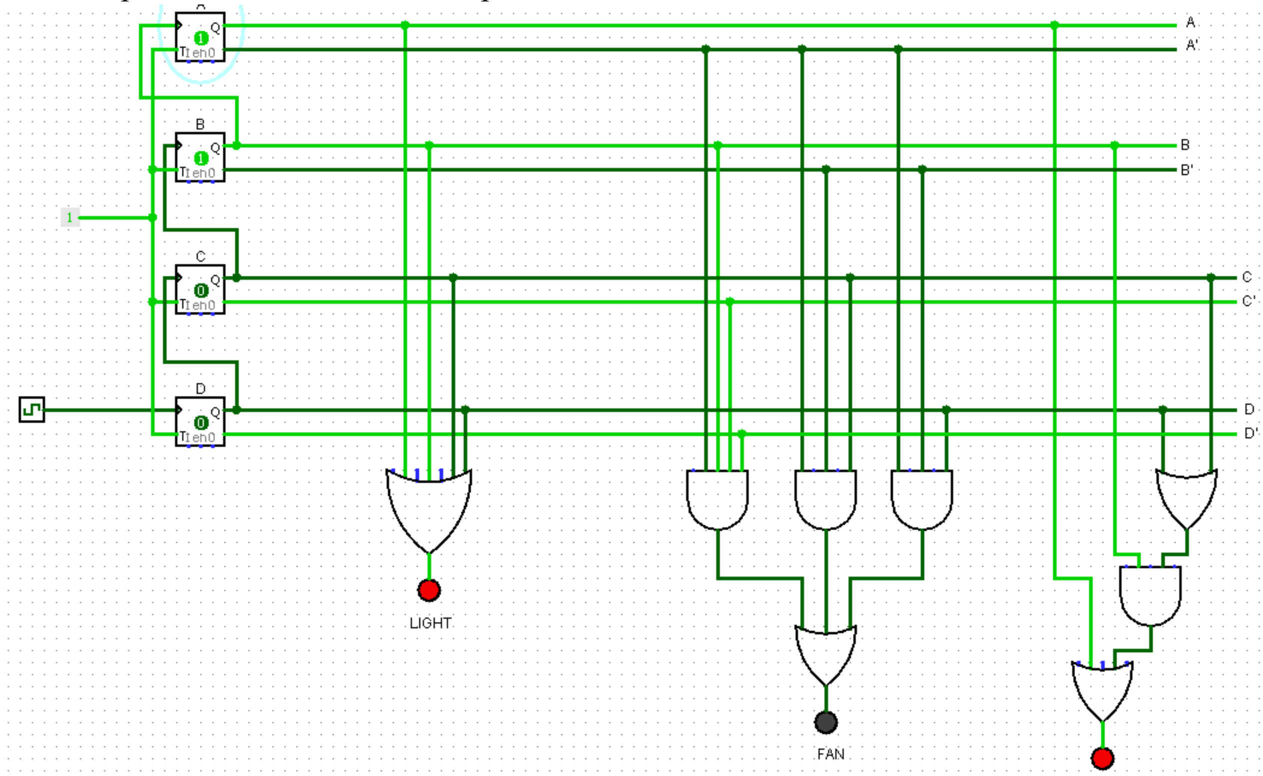
When 10 persons enter the room or input 1010:



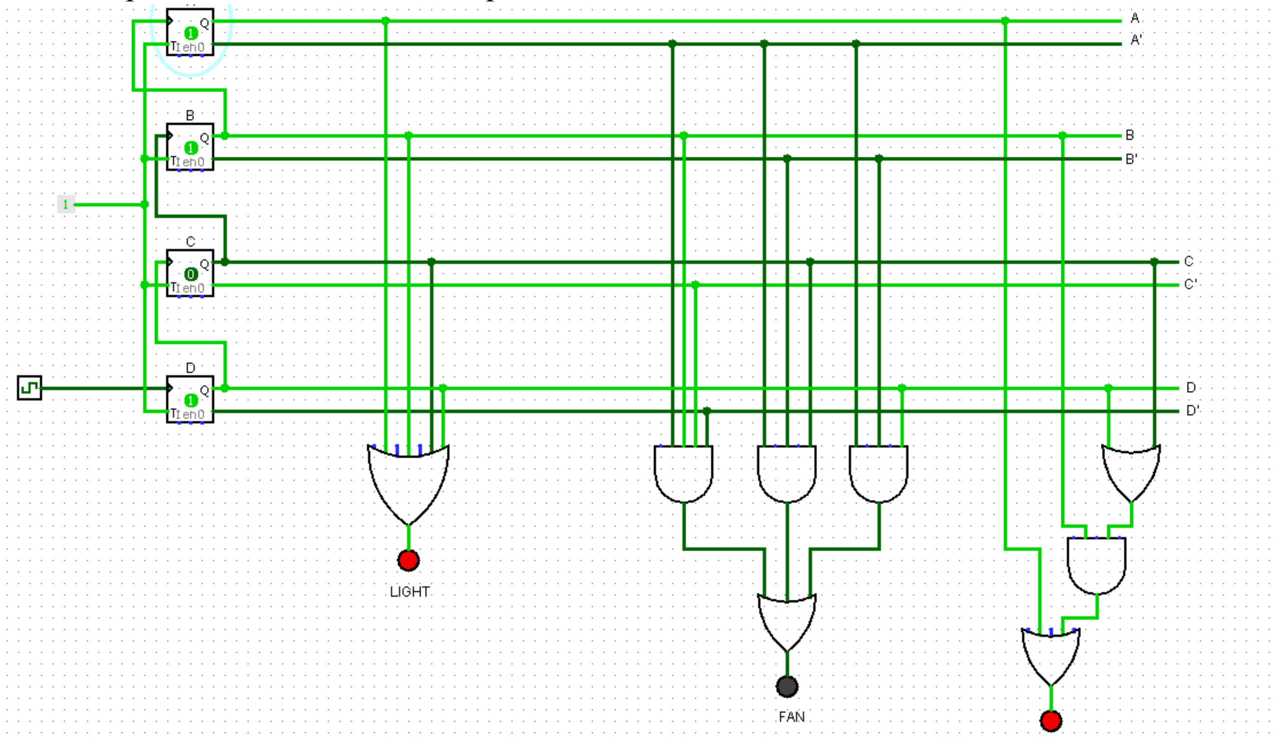
When 11 persons enter the room or input 1011:



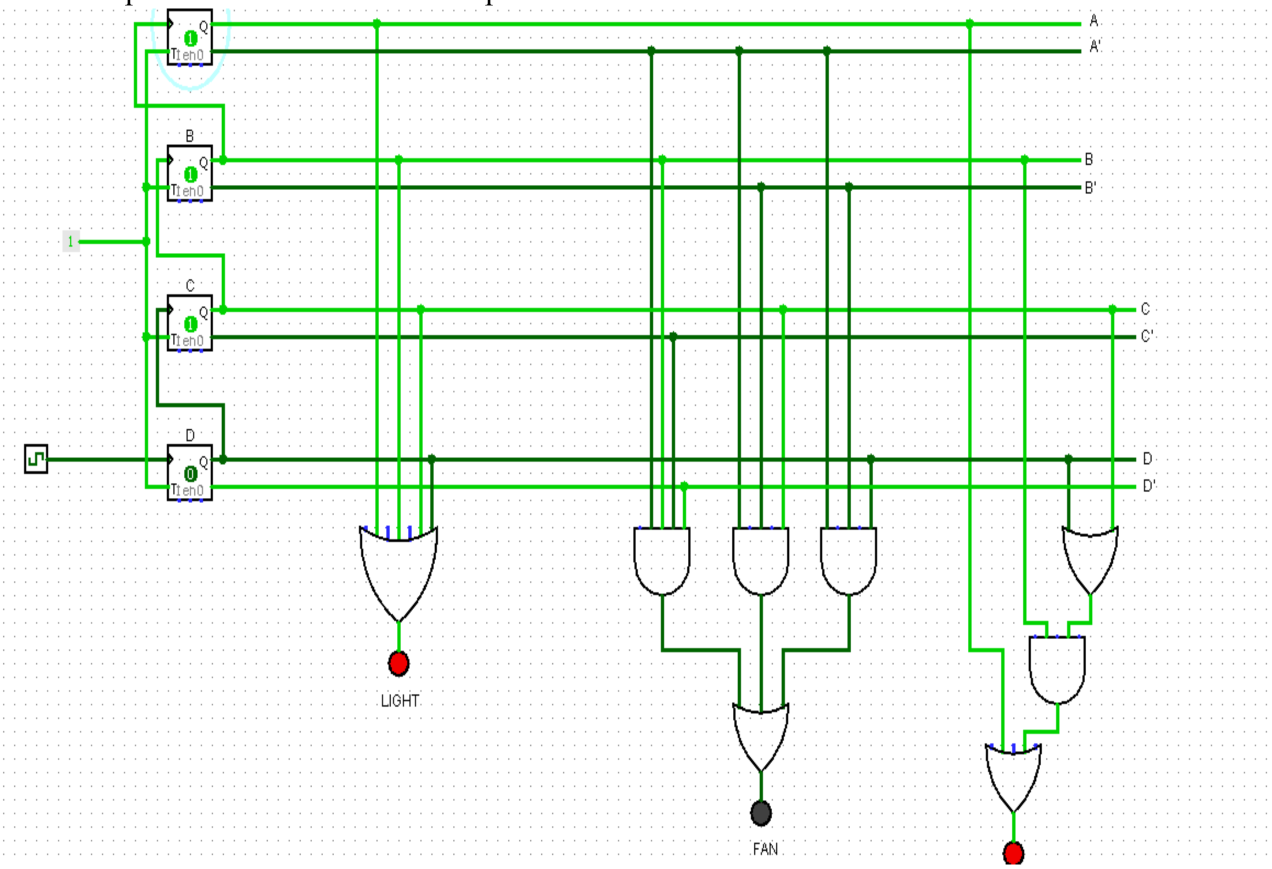
When 12 persons enter the room or input 1100:



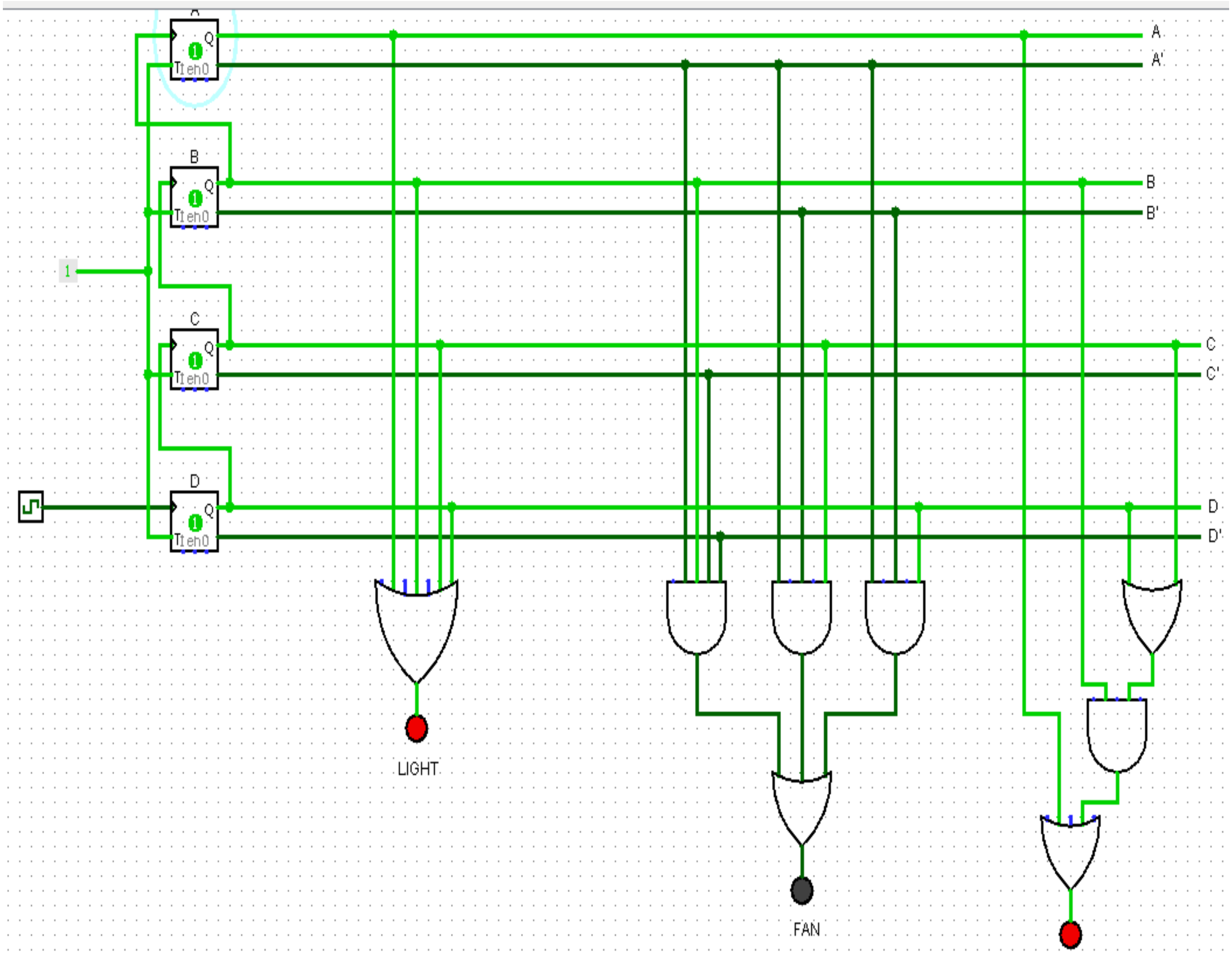
When 13 persons enter the room or input 1101:



When 14 persons enter the room or input 1110:



When 15 persons enter the room or input 1111:



Conclusion

As noted above, we have included in this report an excellent, effective and simple solution in reducing the costs of operating a hospital minivan and operating the building further by using sequential and combinational logic circuits.
We have used several factors to reduce energy costs, namely lighting, temperature, and the number of people.
For example:
When there is at least one person in the room, the lighting and the fan will work,
When there are more than four people in the room, the fan will stop and the air conditioner will start working.

Starting from the state diagram, this report then proceeded to devise the state table and consequently the truth table. The report then implemented techniques such as Karnaugh maps which enables engineers to obtain an efficient way of designing logic circuits.
Based on the results from the truth table and K-maps, we designed our functional logic circuit diagram which is work great as it was checked using simulation.
In this report we focused only on reducing energy costs and we did not focus much on how to count the number of people in a room.
We agreed that in the near and not distant future, we will be able to count the number of people through sensors that are placed at the entrance to each room inside hospitals.

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References:

- https://www.electronics-tutorials.ws/counter/count_2.html
- https://www.youtube.com/watch?v=eEeBh8jfDjg&t=487s
- https://www.youtube.com/watch?v=IrKUFbj7ixg&t=273s
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- https://www.tutorialspoint.com/digital_circuits/digital_circuits_counters.htm
- https://en.wikipedia.org/wiki/Counter_(digital)
- Digital logic design lecture slides

Group work Contribution:

Group Work Contribution

The purpose of this is to encourage all group members to participate fully. This means planning ahead, sound preparation, giving thought to your contribution and meeting deadlines agreed amongst the group members. Please indicate your individual contribution towards the assignment. Key words or bullet points will suffice.

Student 1: **Md. Istiaq Ahmed Bhuiyan**

Contribution:

- Understanding the concept of the idea
- Typing the introduction
- Justifications for each steps and conditions for system design.
- Making the truth table.
- Making the K- Map from the truth table
- Designing and drawing the system circuit diagram.
- Simplifying the K-Map to Boolean expression.
- Designing the system in the simulation software

Student 2: **ALI KHARIMEH**

Contribution:

- Typing the conclusion
- Collecting the ideas
- Helping in organizing the timeline of the report steps
- Drawing the circuits Diagram
- Designing the system in LOGISIM evolution
- Designing the system in the simulation software (circuits diagram)

All students in the group must sign the following:

I agree that the information given by each group member is correct and acceptable		
Student 1: I agree	Student 2: I agree	
Date: 19-May-2020		

Evaluation Form

Checking Points	Total Marks	Given Marks
Clear explanation in presentation (straight to the point)	5 marks	
Explanation on the technical issues pertaining to the design. **Introduction(5marks)** • **System design(10marks)** • **System simulation(10 marks)** • **Conclusion(5 marks)** • **References.(5 marks)**	35 marks	
• Logic Conditions developed • Justifications for each steps and conditions for system design	5 marks	
• Quality of report, understanding and cooperation between members. • **Group work**	5 marks	