DESIGNING A CIRCUIT FOR READING HALL DIGITISATION

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ABSTRACT

We make use of concepts in digital systems to design a circuit to digitize a reading hall and help students find the optimal study spot which usally is time consuming a huge reading hall.Thus, by this we plan to achieve an automatic seat allocation system setup near the entrance of the reading hall to save the student time in finding an optimal seat.The circuit considers conditions set by the user, counts the number of unoccupied seats and displays it through an LED display. For this example, a reading hall with a capacity of 15 was used. Sensors are placed at the entry and exit points to detect the entry and exit of users to automate the process further. Weight sensors are attached to each chair to determine whether a chair is occupied or not. The signals from these sensors are then sent to the logic circuits which consists of different components such as **ADCs**, **adders**, **multiplexers**, **registers**, and **counters**. We define the concepts used in each component. Then we make a flowchart explaining the logic of the circuit, taking us through the different steps in the process of choosing an optimal seat. From the flowchart, we design the circuit and conclude the report.

There will be two doors for the reading hall. One at the entry and one at the exit. A **counter** at each door will count the number of people who entered (**N1**) and exited (**N2**) respectively. Thus instead of a clock pulse here a pulse generated using the ouptut of **IR sensors**. Using IR Sensors in the entry and exit gate we convert the signal from analogue to digital **ADC** which is sent to a **adder** for the entry and to a **subtractor** in the exit. This is used to keep the count of total vacant seats. Let the total number of seats i.e. 15 be stored in N. Using adders and subtractors, we calculate the total number of unoccupied seats as N+N2-N1 and display it using a display decoder.When all seats are occupied it shows no seats vacant. After that, input of the number of people that come into the hall is taken into input. To know if a seat is occupied or not we use a **weight sensor** whose resistor value changes drastically on putting a weight. Thus giving value of high on being occupied and low on being unoccupied. Again an ADC is used.

A **demultiplexer** will be used to pass input high to the chosen number of people in a group. For each number, there is a circuit block which gets activated if chosen. The blocks are shown in the following figures. The logic for the blocks is explained in the flowchart. A single person is not allowed to sit at the 3 chaired and the 4 chaired table. A group is allowed to sit at any table with a sufficient number of unoccupied seats. The LED corresponding to that table will glow if that table is available.

Using **comparators** and a sequential circuit we ensure that for **1 person** coming tables T_1**,** T_2**,** T_3 **,** T_4 **and** T_5 and T_6 are taken into consideration. Thus if the logic value of T_i (i=1 to 4) = (S_i)is 1 thus, seat is occupied . This can be checked using a not of an identity comparator returning a high value if the table is unoccupied. The table number returned as output first will be assigned first. Next if none of the single seat tables are available we check if any seat in any of the double seat table is available i.e S_i (i=5,6,7,8) is available. For this we take active low logic (NAND gates)and return the value of P_5 **=** **(**S_5**.**S_6**)'**, P_6**=(**S_7**.**S_8**)'**. Thus if any of the seat is unavailable it would return the table number and then the value of the seat number which is low can be again checked using a not of an identity comparator and that seat is assigned.

When **2** people arrive we need to check for the tables T_i **(i=5,6,7,8)** is checked if they have two seats vacant. For table T_5 and T_6, NOR of the two seats returns to tell if both seats are occupied or not. For the T_7 and T_8 we check for vacancy by using an AND, OR gates of different combinations of the seats of 3 and 4 seated tables, which returns the glowing led and values of seats available.

When **3** people arrive table T_7 **and** T_8 have to be checked. For seventh table AND of all three seats gives value high whereas T_8 we check for by using an OR gate taking input from the AND gate of each two combinations of the 4 seated table which returns the glowing led and values of seats available.

When a group of **4** people arrive only T_8 needs to be checked if a product or AND of all four seats is high then the table is not vacant.

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I. CONCLUSION

With this, we come to the end of the report. There are a few more things to note before we conclude the report.

A. Limitations

There are bound to be some situations where the circuit may not give the output as desired. Hence, we note some limitations:

- The IR sensors at the entry and exit points may register multiple events when there are many people passing through these points at the same time.
- The circuit may fault if the number of people entering the reading hall is more than the number of total seats.
- The weight sensors may not register the occupancy of chairs properly.
- The circuit is currently considering only 15 seats with a specific arrangement of tables and chairs

B. Future Plans

There are many situations where such a circuit can be used. Some of these situations are restaurants, libraries, movie theatres, auditoriums and many more. The circuit can be developed further to reduce the limitations as mentioned above. We may make use of abstraction and use higher level components to improve the speed and decision making of the circuit. Further, the same logic can be extended to include more number of chairs and different arrangement of tables. Further, more conditions such a preference for AC, a chair near a plug point, etc. can also be included within the circuit.

C. Ending

The concepts defined above can be used to digitise a reading hall. It can also be used in many other places like restaurants, libraries,movie theatres, auditoriums, and many more. We started with a sensor that that the multiplexer makes use of a condition and decides an output from multiple inputs, the From the above discussion, we can make a circuit that counts the number of unoccupied seats in a reading hall and makes use of conditions set by the user to guide them towards the optimal study space in the reading hall.

II. Acknowledgements

We would like to thank Prof. Maniraj Mahalingam sir for giving us this opportunity to work on a group project for EE224. The project helped our understanding of concepts tremendously and gave us an insight into the challenges faced when designing a circuit for a particular real world application.

III. SUPPLEMENTARY

We begin with defining a few important concepts, all of them are with respect to the circuit designed in this report.

- **Logic Gates:** Circuits with one or more binary input signal and a single binary output signal that perform a certain logical operation and follow the rules of Boolean algebra.
- **Multiplexer:** A data selector that selects from several inputs, one output as per an input condition.
- **Adder:** A combinational circuit that adds two binary numbers. There are two main types of adders; half adder and full adder.
- **Subtractor:** A combinational circuit that subtracts one binary number from another binary number. Subtractor works on the same logic as an adder.
- **Register:** A sequential circuit, this makes use of n flip-flops to store n bits of data. The data flow between the flip-flops
- **Counter:** A sequential circuit that counts the number of times an input is given. It has one input line that acts as the clock and n output lines to display a maximum number $2^n - 1$.
- **Analog to Digital Converter (ADC):** A circuit that takes in analog signals and converts them to digital signals for the other components to process.
- **IR Sensor:** An infrared sensor detects the presence of a person and sends an analog signal as an output. This analog signal is then sent to the adder/subtractor to register the entry or exit of a person.
- **Weight Sensor:** A weight sensor determines if there is a weight on the chairs. This tells the logic circuit that a specific chair is occupied.

IV. DESIGNING THE CIRCUIT

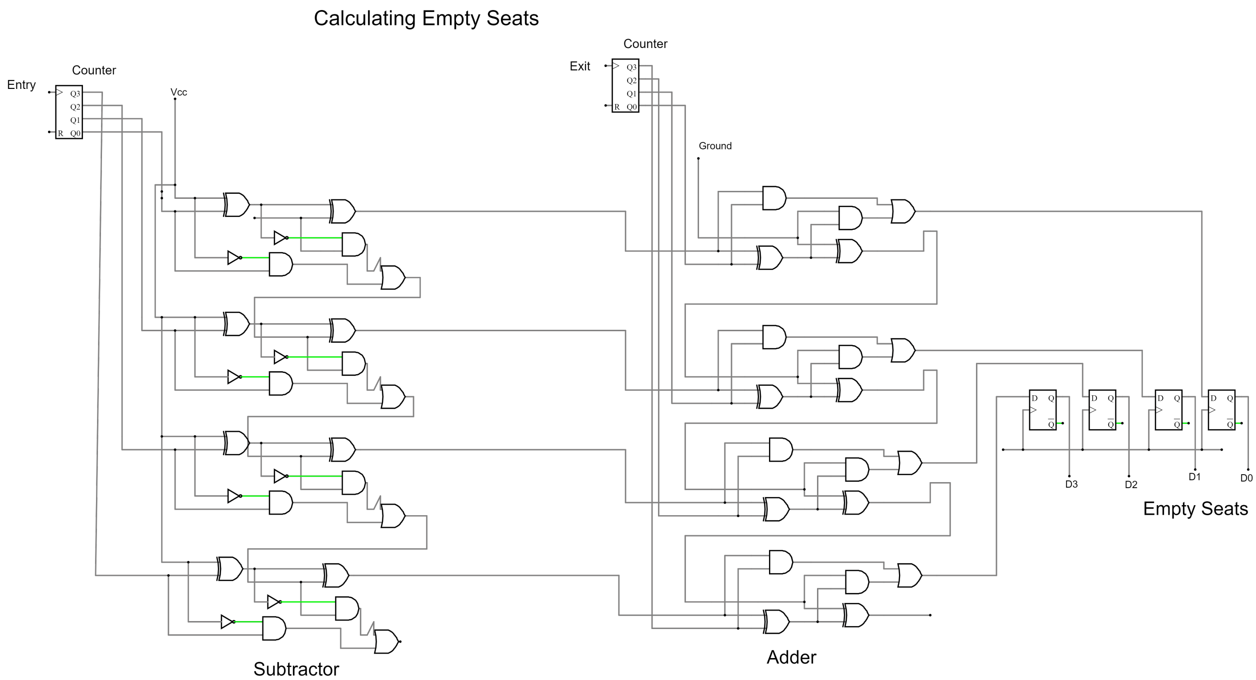

Figure 1. Circuit to display number of vacant seats

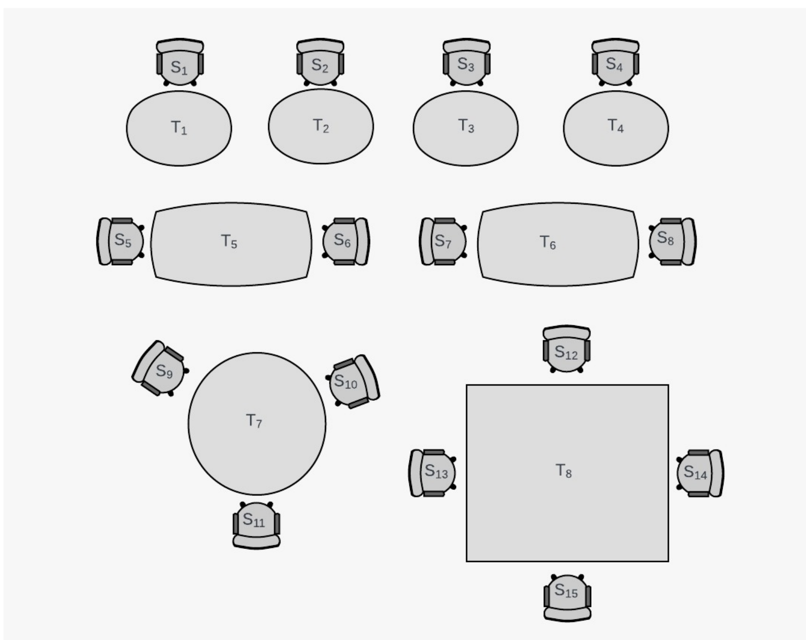

Figure 2. Seating arrangement in the reading hall

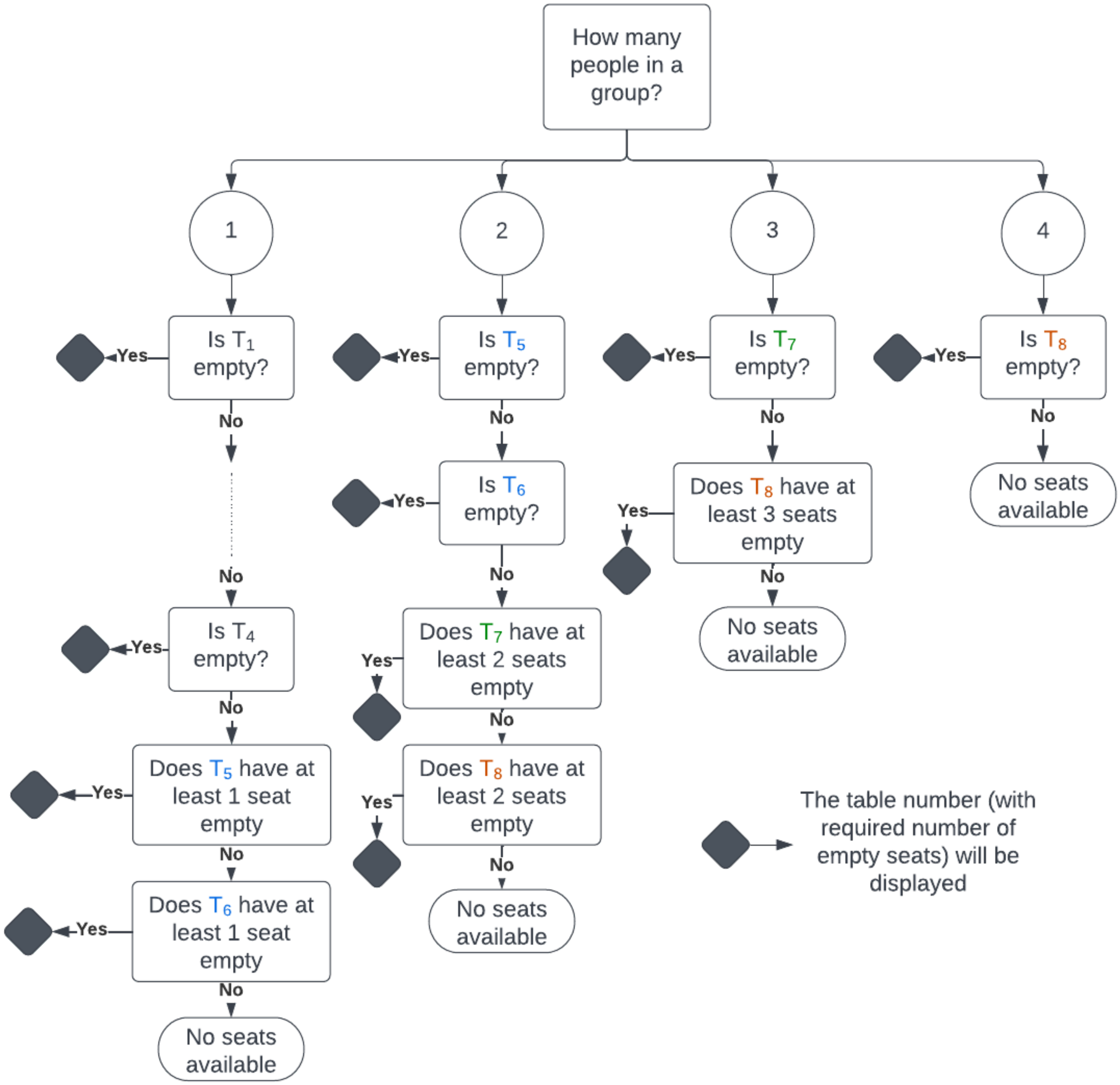

Figure 3. Circuit logic in a nutshell

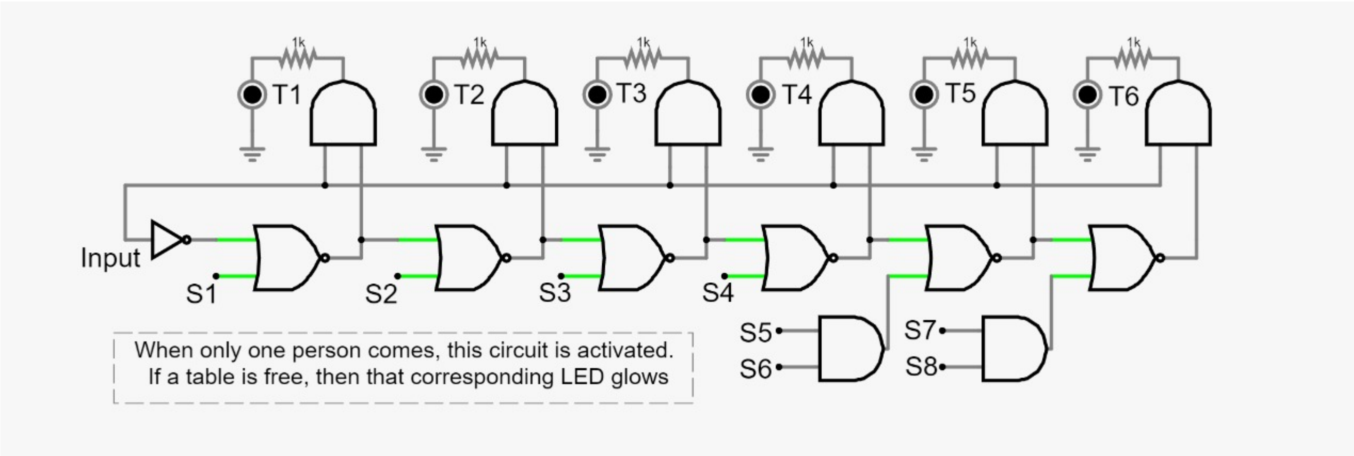

Figure 4. Circuit diagram for 1 person entering

1 PERSON													
S1	S2	S3	S4	S5	S6	S7	S8	T1	T2	T3	T4	T5	T6
1	0	0	0	0	0	0	0	1	0	0	0	0	0
0	1	0	0	0	0	0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	0	0	0	1	0	0	0
0	0	0	1	0	0	0	0	0	0	0	1	0	0
0	0	0	0	1	0	0	0	0	0	0	0	1	0
0	0	0	0	0	1	0	0	0	0	0	0	1	0
0	0	0	0	0	0	1	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1	0	0	0	0	0	1

Figure 5. Truth Table for 1 person entering

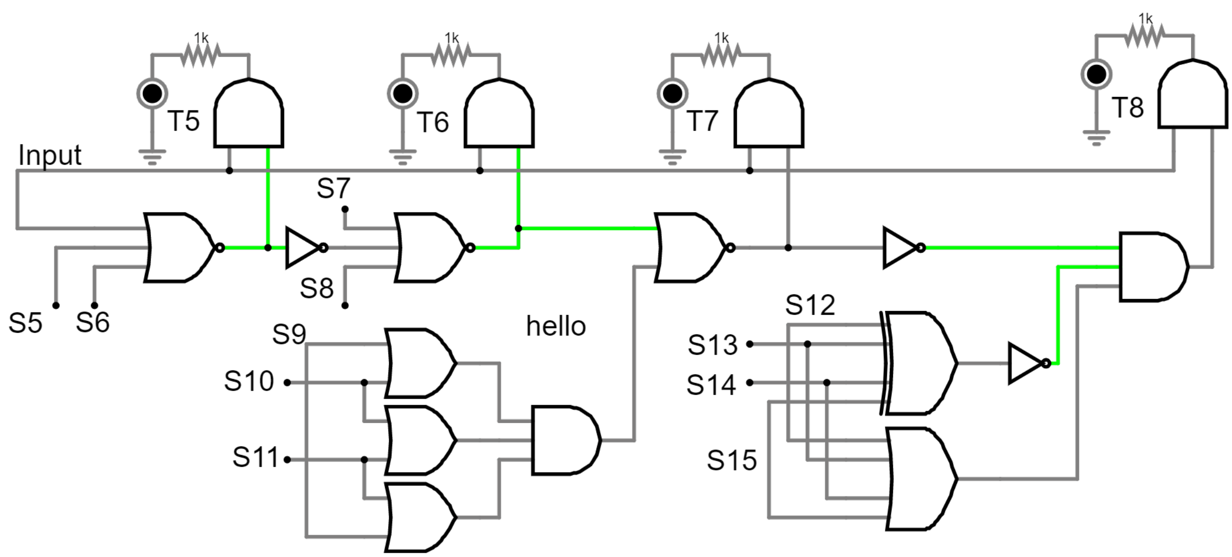

Figure 6. Circuit diagram for 2 people entering

2 PERSON													
S5 / S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	T5	T6	T7	T8
1	0	0	0	0	0	0	0	0	0	1	0	0	0
0	1	1	0	0	0	0	0	0	0	0	1	0	0
0	0	0	1	1	0	0	0	0	0	0	0	1	0
0	0	0	1	0	1	0	0	0	0	0	0	1	0
0	0	0	0	1	1	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	1	0	0	0	0	0	1
0	0	0	0	0	0	1	0	1	0	0	0	0	1
0	0	0	0	0	0	1	0	0	1	0	0	0	1
0	0	0	0	0	0	1	0	1	1	0	0	0	1
0	0	0	0	0	0	0	1	0	1	0	0	0	1
0	0	0	0	0	0	0	1	1	0	0	0	0	1

Figure 7. Truth Table for 2 person entering

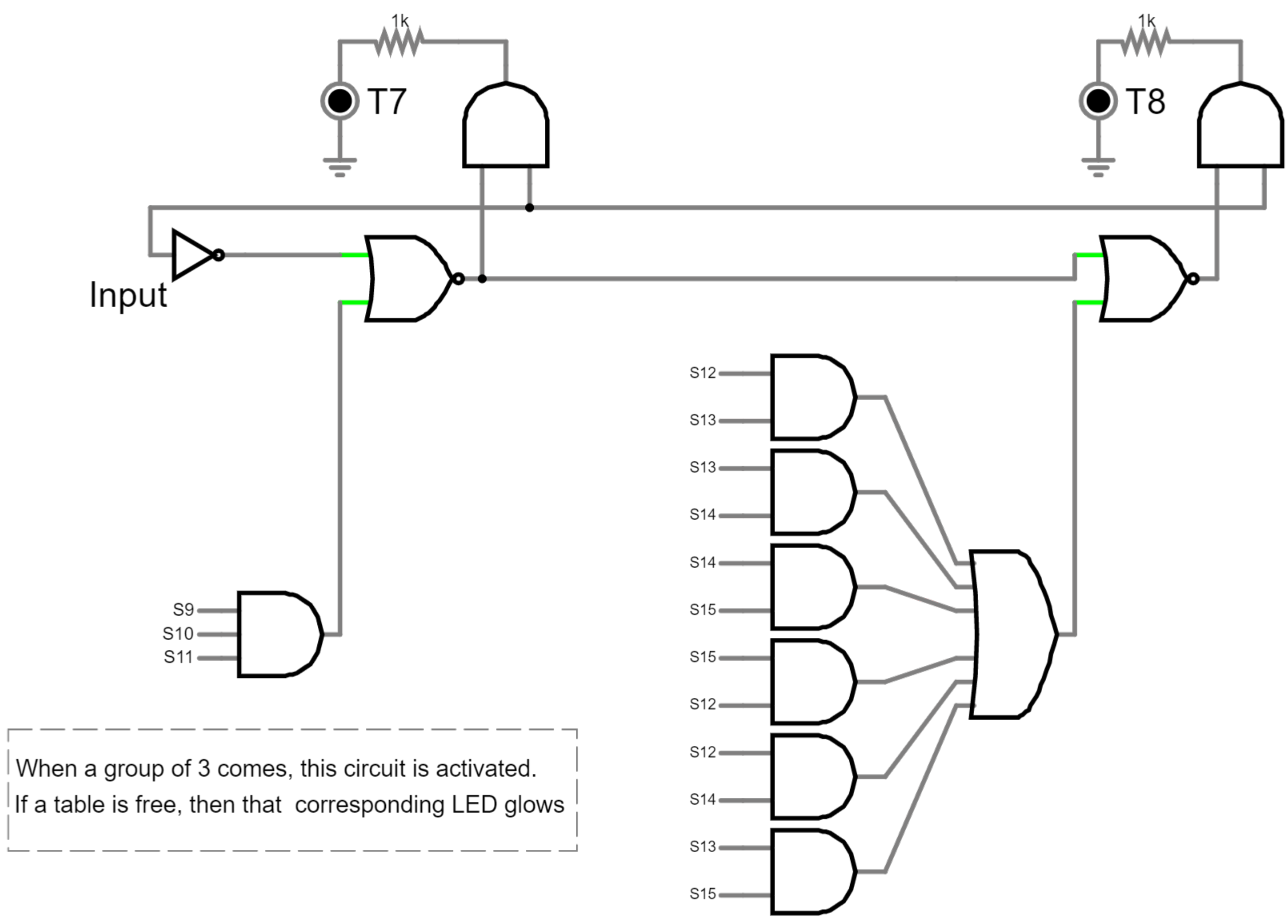

Figure 8. Circuit diagram for 3 people entering

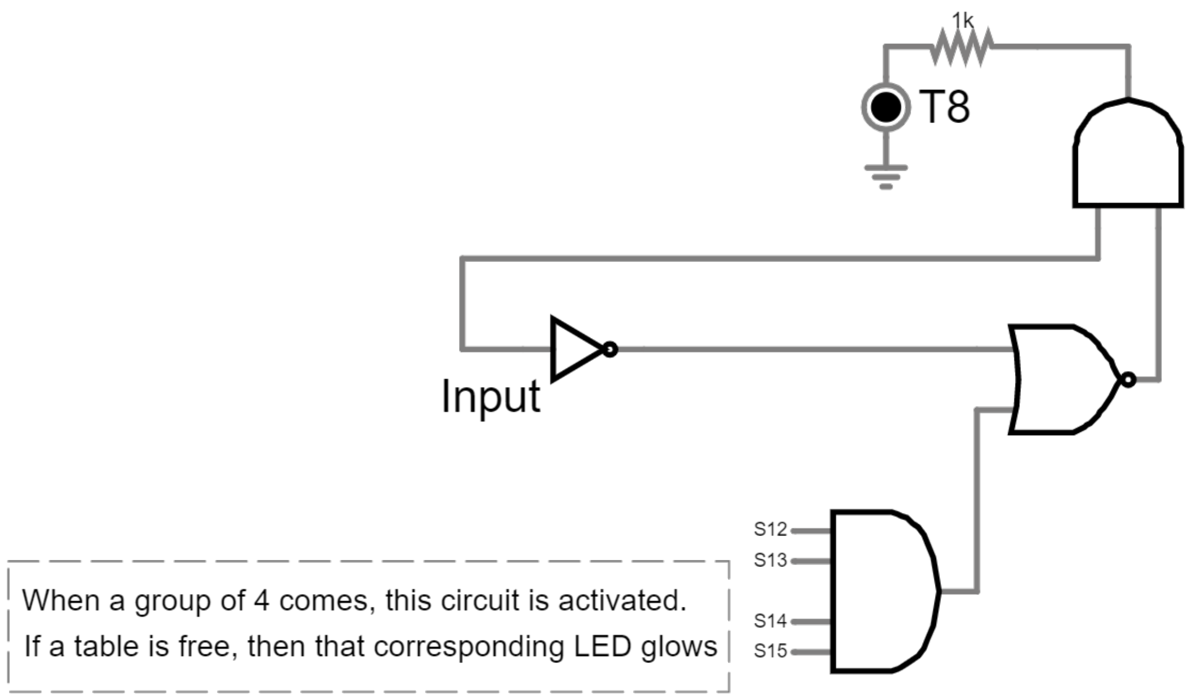

Figure 9. Circuit diagram for 4 people entering

4 PERSON

S12	S13	S14	S15	T1	T2	T3	T4	T5	T6	T7	T8
1	1	1	1	0	0	0	0	0	0	0	1

3 PERSON

S9	S10	S11	S12	S13	S14	S15	T7	T8
1	1	1	0	0	0	0	1	0
0	0	0	1	1	1	0	0	1
0	0	0	0	1	1	1	0	1
0	0	0	1	1	0	1	0	1
0	0	0	1	0	1	1	0	1

Figure 10. Truth Table for 3 and 4 person entering