FACULTY OF COMPUTING

SEMESTER 1 2023/2024

SECRP1013 – DIGITAL LOGIC

SECTION 3

DIGITAL LOGIC PROJECT

(LIFT ELECTRONIC CONTROLLER SYSTEM)

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GROUP 3

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1.0 DEDICATION AND ACKNOWLEDGEMENT

This project is dedicated to our Lecturer, Dr. Nurfazrina Mohd Zamry. We would like to express our gratitude towards her, for teaching us Digital Logic in this semester, and equipping us with the knowledge needed to complete this project. We learned about digital circuits and components and their real-life applications.

We would also like to thank our group members, who worked hard to complete this project and to present it in our best. Working on this project really inspired us and improved our thinking skills and problem-solving skills, along with our ability to interact and cooperate in a team.

2.0 BACKGROUND

In this project, we will implement a password protected lift electronic controlling system, which allows users to input which level they want to go, from 0 to 9, A (10) - F (15) floor. The full circuit is drawn using deeds and includes combinational circuit and sequential circuits.

Combinational circuit components include:

- 4-bit comparator
- 3-bit decoder
- Basic gates
- Seven segment display
- Input switches
- Input push button

Sequential circuit components include:

- 4-bit up/down counter
- 4 D Flip-flops
- Clock disabler
- PRE bar and CLR bar switches

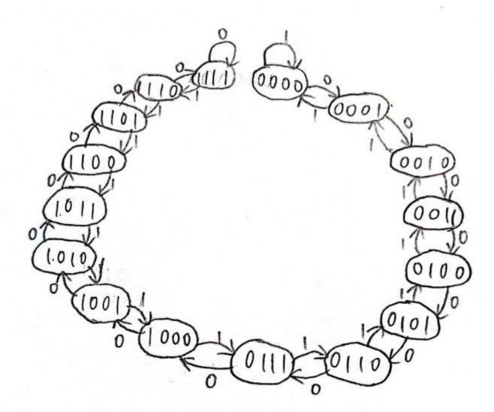
Enhanced features:

- 3-binary digit password
- LEDs for lift going up or down

3.0 PROBLEM AND SOLUTION

To mitigate security concerns, we have introduced a 3-bit binary password system for the lift. The user initiates the process by activating the power and start buttons. Following this, the correct password must be entered, and the desired floor selected. If the password is incorrect, the lift remains stationary. However, upon entering the correct password, LEDs illuminate to display the chosen floor and the lift's motion direction—either up or down—based on the user's destination. Notably, if the number of floors is the same as the destination of the user, the lift will not move as an additional security measure.

This is the state diagram for the lift controller system:



This is the flip-flop transition table for the lift controller system:

Subject:

No:

Date:

Input	Present				Next				D FF			
X	Q_3	Q_2	Q_1	Q_0	Q_{3+}	Q_{2+}	Q_{1+}	Q_{0+}	D_3	D_2	D_1	D_0
0	0	0	0	0	0	0	0	1	0	0	0	1
0	0	0	0	1	0	0	1	0	0	0	1	0
0	0	0	1	0	0	0	1	1	0	0	1	1
0	0	0	1	1	0	1	0	0	0	1	0	0
0	0	1	0	0	0	1	0	1	0	1	0	1
0	0	1	0	1	0	1	1	0	0	1	1	0
0	0	1	1	0	0	1	1	1	0	1	1	1
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0	1	0	0	1	1	0	1	0	1	0	1	0
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1	0	0	0	1	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	1	0	0	0	1
1	0	0	1	1	0	0	1	0	0	0	1	0
1	0	1	0	0	0	0	1	1	0	0	1	1
1	0	1	0	1	0	1	0	0	0	1	0	0
1	0	1	1	0	0	1	0	1	0	1	0	1
1	0	1	1	1	0	1	1	0	0	1	1	0
1	1	0	0	0	0	1	1	1	0	1	1	1
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1	1	1	0	0	1	0	1	1	1	0	1	1
1	1	1	0	1	1	1	0	0	1	1	0	0
1	1	1	1	0	1	1	0	1	1	1	0	1
1	1	1	1	1	1	1	1	0	1	1	1	0

This is the K-map for the lift controller system:

Subject:

No:

Date:

XQ_3 \ $Q_2Q_1Q_0$	000	001	011	010	110	111	101	100
00	0	0	0	0	0	1	0	0
01	1	1	1	1	1	1	1	1
11	0	1	1	1	1	1	1	1
10	0	0	0	0	0	0	0	0

$D_3 = \bar{X}Q_3 + Q_3Q_0 + Q_3Q_1 + Q_3Q_2 + \bar{X}Q_2Q_1Q_0$

XQ_3 \ $Q_2Q_1Q_0$	000	001	011	010	110	111	101	100
00	0	0	1	0	1	0	1	1
01	0	0	1	0	1	1	1	1
11	1	0	0	0	1	1	1	0
10	0	0	0	0	1	1	1	0

$D_2 = XQ_2Q_0 + Q_2Q_1\bar{Q}_0 + \bar{X}Q_2\bar{Q}_1 + \bar{X}Q_3Q_2 + \bar{X}\bar{Q}_2Q_1Q_0 + XQ_3\bar{Q}_2\bar{Q}_1\bar{Q}_0$

XQ_3 \ $Q_2Q_1Q_0$	000	001	011	010	110	111	101	100
00	0	1	0	1	1	0	1	0
01	0	1	0	1	1	1	1	0
11	1	0	1	0	0	1	0	1
10	0	0	1	0	0	1	0	1

$D_1 = \bar{X}Q_1\bar{Q}_0 + \bar{X}\bar{Q}_1Q_0 + XQ_1Q_0 + XQ_3\bar{Q}_1\bar{Q}_0 + XQ_2\bar{Q}_1\bar{Q}_0 + Q_3Q_2Q_1Q_0$

XQ_3 \ $Q_2Q_1Q_0$	000	001	011	010	110	111	101	100
00	1			1	1			1
01	1			1	1	1		1
11	1			1	1			1
10				1	1			1

$D_0 = \bar{X}\bar{Q}_0 + Q_3\bar{Q}_0 + Q_2\bar{Q}_0 + Q_1\bar{Q}_0 + \bar{X}Q_3Q_2Q_1$

4.0 BLOCK DIAGRAM

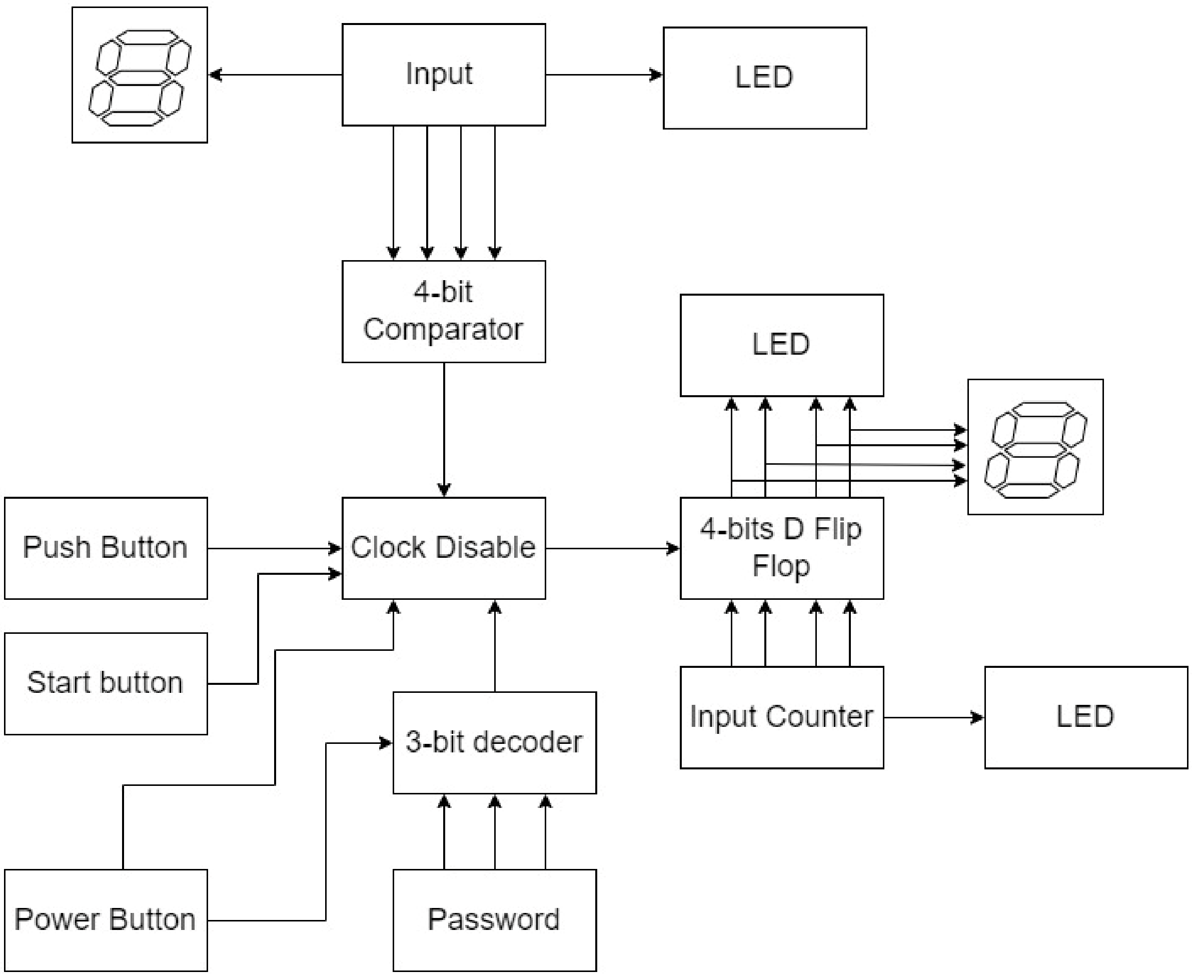


Fig 1: Block diagram

5.0 THE REQUIREMENTS

- Input switch

  The user can enter their destination using the four input switches. The user can also turn on the power and start button of the lift using the switches.

- Input push button

  The push button is to eliminate unwanted state during transition state.

- Input switch X

  The user can choose the motion of the lift, either goes up (count up) or goes down (count down).

- Clock disabler

  The clock disabler is active only when all the inputs (power and start) are high, and the password is correct. It also controls the counter operation when the destination is reached.

- 4-bit count up/down counter

  The counter begins and ends its counting operation depending on the clock disabler and input switch X.

- 7-Segment display

  The 7-segment display shows the destination of the user and the number of floors of the lift.

- 3-bit decoder

  The decoder will decode the password entered by user and only the password 100 can activate the circuit.

- 4-bit comparator

  The comparator is to compare the destination of the user and the number of floors of the lift. If both are on the same floor, the lift will not move.

- LED

  The LEDs will light up to indicate the number of floors of the lift and the motion (lift goes up or lift goes down) of the lift based on the destination of the user.

- D Flip-flops

  D Flip-flops act as a level indicator for the lift.

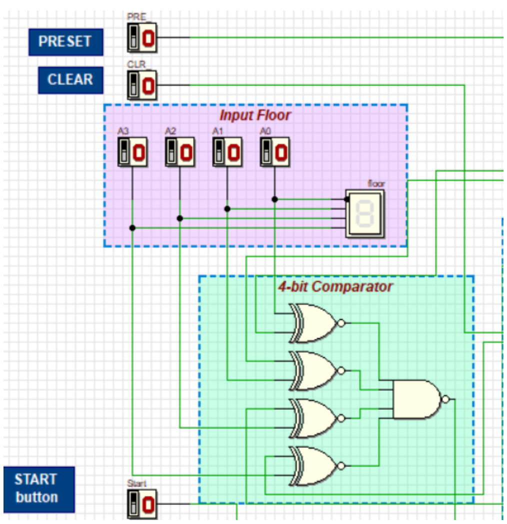
- PRE bar and CLR bar button

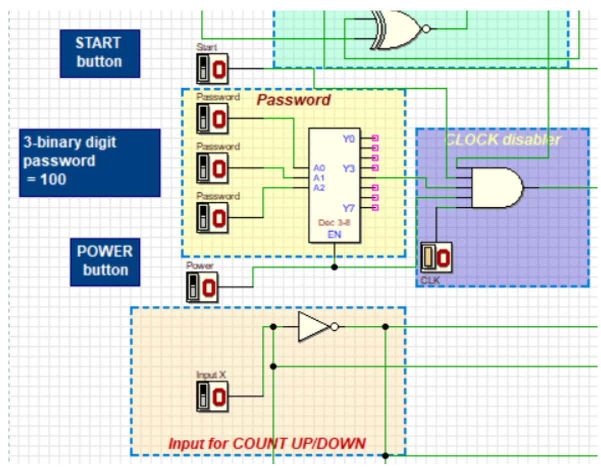
  The PRE bar and CLR bar button is set to 1 to make the circuit operate in synchronous mode.

6.0 System implementation

1. Input switch

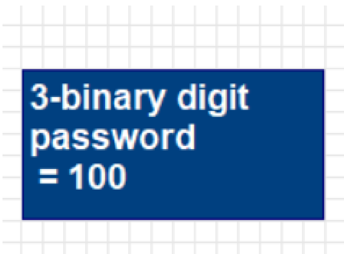
Initially, there were two input switches designated for the preset and clear buttons. Activating both switches, with the preset button set to 1 and the clear button set to 1, induces a synchronous state in the circuit. This state utilizes the input push button as a clock for synchronized operations. Furthermore, a singular input switch serves as the power button, initiating the entire system. Additionally, three input switches are provided for residents within the block to input a password, a security measure ensuring that only authorized individuals can access the elevator, thereby guaranteeing resident safety. These password input switches, denoted as A0, A1, and A2, represent single bits, with A0 denoting the least significant bit (LSB) and A2 representing the most significant bit (MSB). Linked to a 3-bit decoder, these switches enable residents to input specific binary configurations, thereby activating the elevator securely. Furthermore, an array of four input switches allows residents to specify the desired floor, with the output connecting to a 7-segment display for clear floor indication. Additionally, a single input switch serves as the start button, initiating the elevator process. Finally, residents have the option to choose between counting up (0) or counting down (1) based on the switch 'X'.

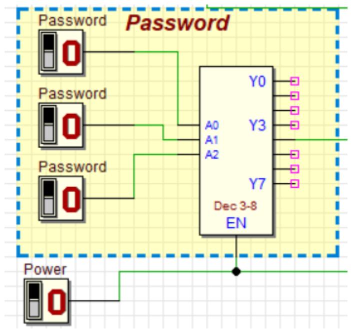




2. 3 bit – Decoder

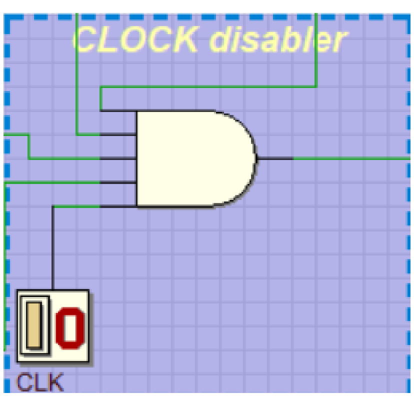
We want to set a 3-binary-digit password. Thus, we use a 3-bit decoder to decode the set of binary passwords. The enable pin of the 3-bit decoder is connected to the power button, which means the decoder will only activate when the power button is activated. Only when the correct password is input by the resident and the power is activated will the output of the decoder be high. The output of the decoder is connected to a clock disabler to check if the clock is functioning or not.





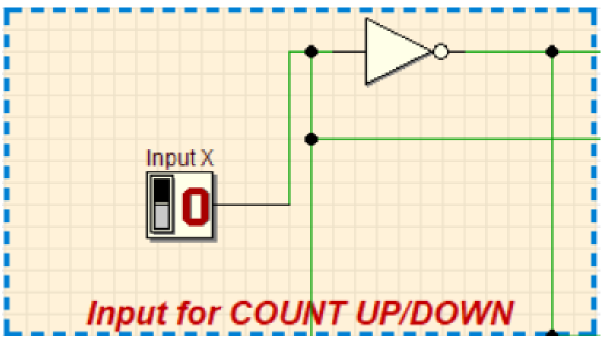
3. Clock Disabler

The clock disabler is configured using a 5-input AND gate. The 5-input AND gate receives input from the clock source, a 3-bit decoder, a start signal, a power button signal, and a comparator signal. The clock disabler will only be active if all five inputs are high. The output of the 5-input AND gate is connected to the counter's flip-flop clock. It used to start and stop the counter's operation when the number of targeted and current floors were reached.



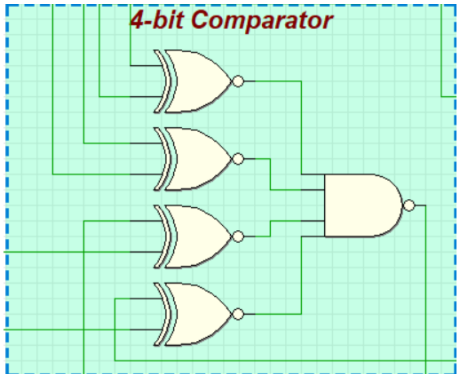
4. 4 -bit count up/down counter

In our system, we utilize a 4-bit D positive edge count-up/down counter. When input X is connected to a low input and the current floor level is less than the target floor, the counter initiates count-up, incrementing with each clock pulse until reaching the target floor, simulating the elevator moving up. Conversely, when input X is connected to a high input and the current floor level exceeds the target floor, count-down functionality is activated, decrementing with each clock pulse, simulating the elevator moving down. The counter operates upon the correct password entry, facilitated by an AND gate implementing an active high input. Incorrect passwords prevent counting, ensuring security. The counter operates on positive clock edges and stops either when the clock pulse ceases, or the user-defined count limit is reached.



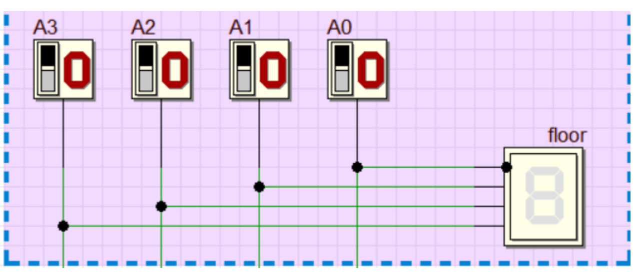
5. 4 bit-Comparator

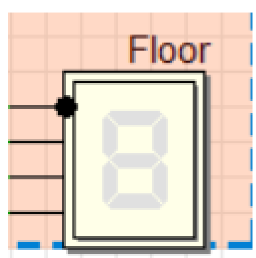
The comparator circuit is designed with four 2-input XNOR gates, facilitating the comparison of values from two distinct sources: the input switches for the user's desired floor and the current floor occupied by the user. Each XNOR gate focuses on a specific bit, starting with the least significant bit (LSB). The XNOR gates operate on the principle that when the number of requested floors and the user's current floor match, the output is 0 due to the nature of the XNOR gate; this output is then inverted to 1. The same principle can be applied for the second, the third and the fourth XNOR gate. Then, the signal from all four gates will be sent to a NAND gate to convert it into the opposite signal. Therefore, when the input of the NAND gate receives the high input (1) given from input switches, it will send an output 0 to the clock disabler to stop the lift.



6. 7-Segment Display

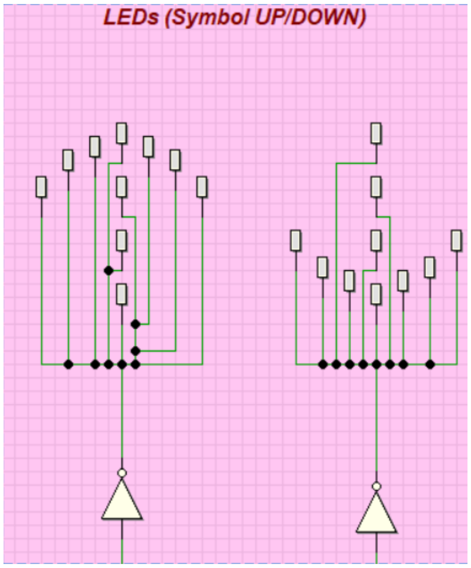
The 7-Segment Display plays a crucial role in our system, providing a visual representation of the selected and current floor levels. Connected to the user's desired level input, one 7-Segment Display dynamically showcases the chosen floor, ensuring users have a clear indication of their intended destination. Simultaneously, a second 7-Segment Display is dedicated to displaying the lift's current floor level as it ascends or descends. With the ability to portray decimal numbers from 0 to 9 and letters from A to F, covering the entire range of 0 to 15 floors, these displays contribute to a user-friendly interface, allowing passengers to easily interpret and confirm their selected and current floor levels within the lift.





7. LED

The LEDs are configured by connecting to the input switch "X"; the LED symbol UP illuminates when the input "X" is 0, and the LED symbol DOWN illuminates when the input "X" is 1. This allows the LEDs to indicate whether the elevator is moving up or down.



7.0 Full Deeds circuit

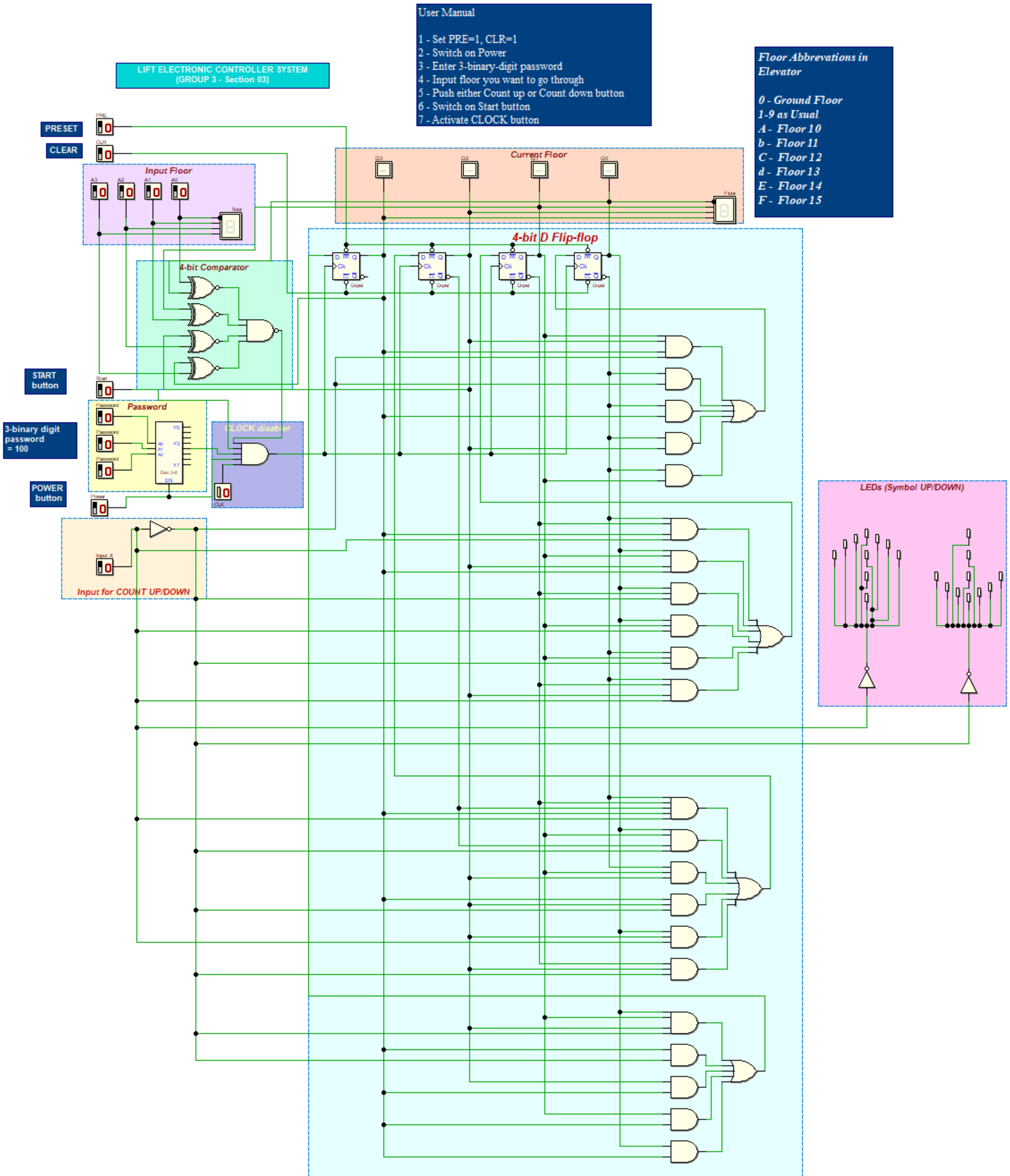


Fig 2: Full deeds circuit

8.0 Conclusion and Reflection

In conclusion, the lift controller project has resulted in a user-friendly design incorporating essential components such as a 3-bit decoder, input switches, 4-bit comparator, seven-segment displays, LEDs, and a 4-bit D flip-flop, creating an efficient lift electronic controller system. The integration of a password feature enhances security and control over the circuit, while the implemented LEDs provide clear indications of the lift's directional movement.

The collaborative efforts and successful teamwork throughout the project underscore the importance of effective collaboration in achieving milestones and overcoming challenges. Looking ahead, we aim to apply our enriched knowledge in real-life situations by working on more complex circuits with additional features, further advancing our skills in electronic control systems.

Reflecting on this journey, the project has been a valuable learning experience, contributing significantly to our knowledge and skill development in electronic control systems, security protocols, and user interface design. The practical insights gained from hands-on experience will undoubtedly shape our approach to future projects, reinforcing the impact of collaborative efforts and technical proficiency in achieving successful outcomes in the field.

9.0 References

[1] Digital logic Module

[2] Digital logic lab

10.0 Appendices

Cover page – Lau Yee Wen

Background – Cheryl Cheong Kah Voon

Problem and solution – Chua Jia Lin

Block diagram – Cheryl Cheong Kah Voon

Requirements – Chua Jia Lin

System Implementation – Gui Kah Sin & Lau Yee Wen

Deeds circuit – Gui Kah Sin & Chua Jia Lin

Conclusion& Reflection – Lau Yee Wen

Video editing - Cheryl Cheong Kah Voon

Report finalizing – Gui Kah Sin

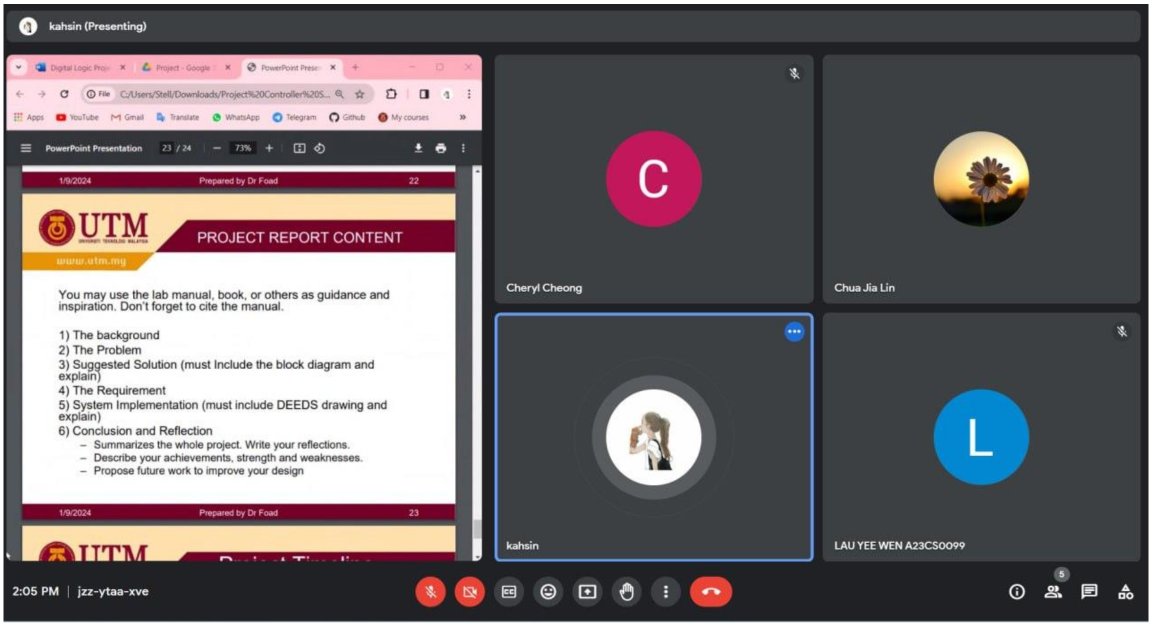


Fig 3: Group 3 working together on google meet

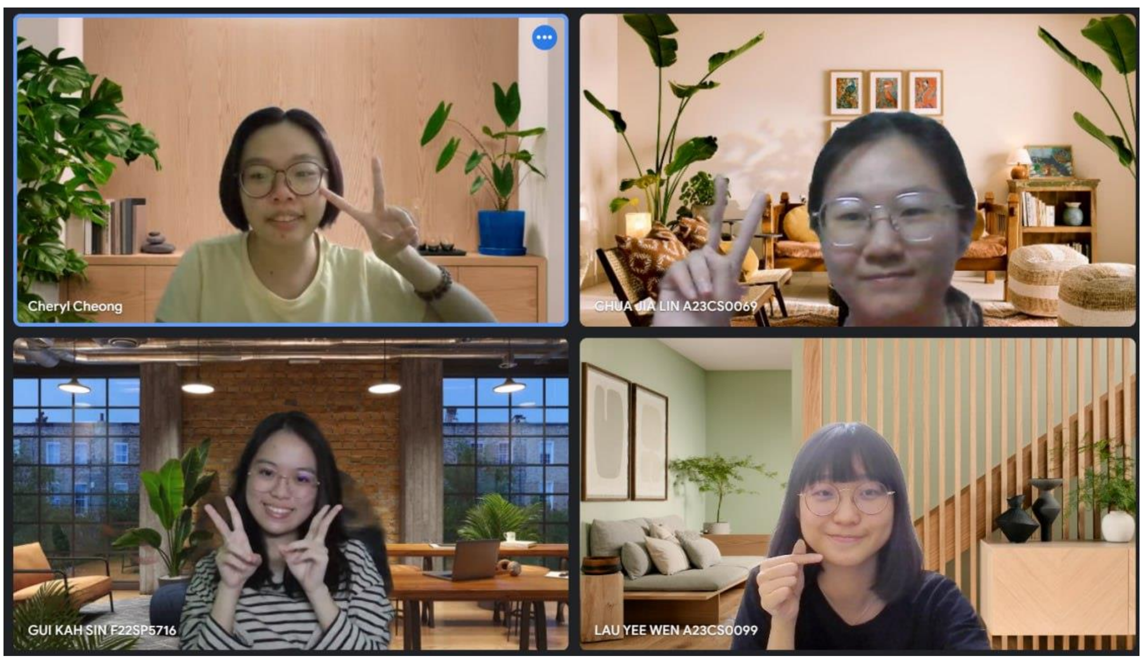


Fig 4: Group 3 presentation

Video Link: https://youtu.be/CO0RaZ7JONs