Smart Room Code Lock

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This project focuses on the design and implementation of a "Smart Room Code Lock" using digital logic circuits. The system utilizes five 4017 decade counter ICs, an AND gate IC, and LEDs to create a secure code-based locking mechanism. The primary objective is to allow access only when a predefined sequence of inputs (code) is entered correctly. Each 4017 IC controls 10 LEDs, and the output of specific LEDs acts as inputs to an AND gate, which verifies the correct sequence. Upon successful input, the final output LED turns on, indicating access granted. This report details the components, circuit design, and working principles behind the code lock system.

1. Introduction

1.1 Background

In today's security-conscious world, digital locks provide an effective way to secure rooms, cabinets, and other restricted areas. Traditional locks can be easily compromised, whereas a digital code lock offers enhanced security. This project aims to create a simple yet effective "Smart Room Code Lock" using basic digital logic components such as 4017 ICs and an AND gate.

1.2 Objectives

The goal of this project is to design and implement a secure room access system that unlocks only when a specific sequence of numbers (code) is entered.

The system uses:

- Five 4017 decade counter ICs to handle user input.
- An And gate to validate the sequence .
- LEDs to indicate system status and correct input.

1.3 Significance

This project demonstrates the practical application of digital logic design principles in real-world security systems. It provides hands-on experience with counter ICs, logic gates, and circuit design.

2. Project Requirements

2.1 Functional Requirements

- The system should unlock access only when the correct sequence of the number is entered.
- Each 4017 IC should control 10 LEDs, displaying the current input
- The output of the AND gate should turn on the final LED when the correct sequence is entered.
- Push buttons should be used to input each number in the sequence.

2.2 Technical Requirements

- **Power supply:** 5V DC
- **ICs:** Five 4017 Decade Counter ICs, One And Gate IC.
- **LEDs:** 51 LEDS (50 for user inputs, 1 for the final output).
- **Resistors:** Six 220 Ohm, Five 1k Ohm, Five 10k Ohm.
- **Breadboards:** Five Breadboards for Circuit prototype.
- **Wirings:** Four set of jumper wires for connections.

2.3 Cost Requirements

Component	***Quantity***	***Cost (pkr)***	***Total (pkr)***
4017 IC	5	100	500
AND IC	1	50	50
LEDs	51	5	255
Push buttons	5	10	50
Breadboard	5	250	1250
Resistor(220ohm)	6	1	6
Resistor(1k ohm)	5	1	5
Resistor(10kohm)	5	1	5
Wires (set)	4	250	1000
Battery (5v)	1	120	120
Total cost	-	-	3241

3. Project Description

This project uses five 4017 decade counter ICs, an AND gate IC, and LEDs to create a code lock system. The system works by allowing a user to press push buttons in a specific sequence, lighting up corresponding LEDs controlled by the 4017 ICs. Each 4017 IC can control 10 LEDs, advancing the output to the next LED with each button press.

The logic behind the system involves connecting specific LEDs from each 4017 IC to the inputs of an AND gate. When the user presses the buttons in the correct order, the designated LEDs turn on. If all the designated LEDs are lit simultaneously, the AND gate outputs a HIGH signal, turning on the final LED to indicate successful access.

3.1 Working of 4017 IC

The 4017 IC is a decade counter that advances its output each time a pulse is received on its clock pin (Pin 14). The 10 output pins (Pins 3, 2, 4, 7, 10, 1, 5, 6, 9, 11) light up LEDs sequentially with each button press. The IC is reset using Pin 15, and its clock enable pin (Pin 13) is tied to ground to allow counting.

3.2 Building a 4017 IC using Basic Logic gates

In our project we used the 4017 decade counter IC itself for efficiency but we can replicate the behaviour of a 4017 decade counter IC using basic logic gates as well.

- Core Components:

- Flip-Flops: Use JK Flip-Flops or D-Flip-Flops to create the coutning mechanism.
- And gates: To manage the Logic of the resetting the count after 10 (a decade counter).
- Clock Input: To provide pulses for Counting.

- Logic Explanation:

- The 4017 IC is a decade counter (counts from 0 to 9). It uses a divide-by-10 counter, which can be implemented using 4 Flip-Flops.
- The outputs of the Flip-Flops represent a **binary count**. To achieve a sequence that resets after 10, additional logic gates are used to detect the count of 10 (binary **1010**) and reset the counter.

- Circuit Design:

- Use 4 Flip-Flops in series.
- Connect the clock input to the first flip-flop
- Connect the Q output of each Flip-Flop to the clock input of the next Flip-Flop.
- Use an AND gate to detect when the output equals 1010 (10 in binary).
- When this condition is met, the AND gate sends a reset pulse to all Flip=Flops.

- Truth Table:

Clock Pulse	**Q3**	**Q2**	**Q1**	**Q0**	**Decimal**
0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	2
3	0	0	1	1	3
4	0	1	0	0	4
5	0	1	0	1	5
6	0	1	1	0	6
7	0	1	1	1	7
8	1	0	0	1	9
9	1	0	0	1	9
10 (Reset)	1	0	1	0	Reset

- Boolean Expression For Reset:

To reset at **1010** (Q3 = 1, Q1 = 1), the Boolean expression for the reset signal is:

Reset = Q3 . Q2' . Q1 . Q0'

- Summary:

- 4 Flip-Flops create the binary counting sequence.
- AND gates generate the reset logic.
- This approach replicates the behaviour of the 4017 IC, though the actual 4017 IC is more compact and efficient for practical use.

3.3 Logic of push button and LED Activation

- Button Press: Each push button press sends a pulse to the clock pin of the 4017 IC, lighting up the next LED in sequence.

- AND Gate Logic: Specific LEDs from each 4017 IC are connected to the inputs of an AND gate. For example for a 12345 code:

1st LED of the 1st 4017 IC => 1st input of the AND gate.
2nd LED of the 2nd 4017 IC => 2nd input of the AND gate.
3rd LED of the 3rd 4017 IC => 3rd input of the AND gate.
4th LED of the 4th 4017 IC => 4th input of the AND gate.
5th LED of the 5th 4017 IC => 5th input of the AND gate.

-Final Output: When all these LEDs are lit, the AND gate output becomes HIGH, turning on the final LED, which indicates access granted.

4. Circuit Design and Implementation

4.1 Components used

Component	***Quantity***
4017 IC	5
AND IC	1
LEDs	51
Push buttons	5
Breadboard	5
Resistor(220ohm)	6
Resistor(1k ohm)	5
Resistor(10kohm)	5
Wires (set)	4
Battery (5v)	1

4.2 Circuit Description

The circuit uses five 4017 ICs, each responsible for controlling 10 LEDs. The pin configuration for each 4017 IC is as follows:

- **Pins 3, 2, 4, 7, 10, 1, 5, 6, 9, 11:** Connected to the anodes of 10 LEDs.
- **Pin 16:** Connected to +5V DC power supply.
- **Pin 14:** Connected to a push button switch, which is also pulled down to ground using 1k Ohm resistor
- **Pin 8, 13, 15:** Connected to ground.

The circuit is replicated for all five 4017 ICs.

4.3 Sequence Verification

The output of the AND gate will be HIGH only if all five inputs are HIGH, indicating the correct code has been entered. This HIGH output powers the final LED, signalling successful access.The specific LEDs that correspond to the correct code are connected to the AND gate inputs. If all these LEDs are lit then it means that the correct sequence has been entered.

4.4 Truth Table

Input 1 (4017 IC 1)	**Input 2 (4017 IC 2)**	**Input 3 (4017 IC 3)**	**Input 4 (4017 IC 4)**	**Input 5 (4017 IC 5)**	**AND Gate Output**
0	0	0	0	0	0
1	0	0	0	0	0
1	1	0	0	0	0
1	1	1	0	0	0
1	1	1	1	0	0
1	1	1	1	1	1

- 1 indicates the correct LED for that IC is lit (High).
- 0 indicates the LED is not lit (Low).
- The AND gate output is High (1) only when all five input are HIGH (1), meaning the correct code sequence has been entered.

4.5 Boolean Equation

Let:

- **A** = Output of the 1st 4017 IC.
- **B** = Output of the 2nd 4017 IC.
- **C** = Output of the 3rd 4017 IC.
- **D** = Output of the 4th 4017 IC.
- **E** = Output of the 5th 4017 IC.

The output of the AND gate **(Y)** is :

Y = A . B . C . D . E

4.6 Units Table

Components	**Measurement**	**Unit**	**Symbol**
Battery	Voltage	Volts	V
Resistor	Resistance	Ohms	Ω

5. Results

5.1 Observations

- The circuit successfully validates the predefined code sequence.
- When the correct sequence is entered, the AND gate output becomes High, and the final LED turns on.
- Entering any incorrect sequence does not activate the AND gate output.

5.2 Challenges

- Ensuring proper connections on the breadboard.
- Mainting stable power supply for all five 4017 ICs.
- Avoiding false triggering due to noise or loose connections

5.3 Limitations

- The system only works for a fixed sequence. Changing the code requires reconfiguring the connections.
- The circuit is limited to 5 inputs due to the AND gate's input capacity

6. Conclusion

Our "Smart Room Code Lock" project successfully demonstrates the use of digital logic components to create a secure access system. By using 4017 ICs and an AND gate, the system ensures that access is granted only when the correct sequence is entered. This project offers a practical application of digital logic design and can be expanded for more complex security systems.

7. Future Improvements

- **Code Customization:** Implement a way to easily change the code without rewiring the circuit.
- **Increased Security:** Add more 4017 ICs and And gate inputs to allow longer code sequences.
- **Alarm System:** Intergrate an alarm that triggers after multiple incorrect attempts.
- **Micro-controller Integration:** Replace the AND gate logic with a micro-controller to allow more flexibility and security features.

8. Schematic Diagram