King Abdulaziz University

Faculty of Computing & Information Technology
Computer Science Department

Digital Logic Design

CPCS-211
Final Project Report
(First Term 2022)

Submitted By: Wajd Alharbi
Student Number : 2007057
Project Title : Safety Box Circuit

	Max. Marks	Obtained Marks
1. Report	15	
2. Circuit	5	
Total Score	20	

Topics

1. Introduction
2. Digital Circuits
3. Analog Vs Digital Circuits.
4. Types of Digital Circuits

    4.1 Combinational Circuits
    4.2 Sequential Circuits
    4.3 Difference between Combinational and Sequential Circuits

5. Description of the main idea in your project:

    5.1 What do you want to design?

    5.2 The most common device that will be used in your project.

6. Design Steps

7. Circuit layout

8. Bibliography

1. Introduction (1 Mark)

I'm working on a safety box circuit. One switch is used to save the right code for opening the safe, while the other switch is used to enter data. The light glows green if the codes match, but the red LED will light up if they don't.

2. Digital Circuits (1 Marks)

The transmission of power to an electronic device is accomplished using a digital circuit. It can be utilized to carry out a variety of tasks depending on the input given to the electronic circuit. A digital circuit can only function with discrete values of 0 or 1. The analog signal can be converted to digital values using an analog to digital converter.

3. Analog Vs Digital Circuits

• Definition for analog and digital circuits

Analog Circuit: **(2 Marks)**
An analog circuit is an electrical circuit that processes analog data or signals and outputs analog data or signals. They're made up of resistors, capacitors, and inductors, among other analog circuit components.

Digital circuit: **(2 Marks)**
A digital circuit is an electrical circuit that processes data or signals with discrete amplitude, often known as digital signals. They're made of digital logic gates, as these are the integral elements of any digital circuit.

• Analog and Digital circuits functionality and their uses.

An analog circuit has a continuous, changeable signal, as opposed to a digital circuit, which has a signal that can only be one of two distinct levels. Changes in current, voltage, or frequency can be used to convey information in analog circuits within electrical equipment.

A digital circuit has a signal that must fall into one of two discrete levels. Each level is read as one of two states (on/off, 0/1, true/false, for example). To conduct Boolean logic, transistors are used to generate logic gates in digital circuits.

• Differences (at least three) between these two types of circuits.

Analog circuit	Digital circuit
Only analogue or continuous amplitude signals can be processed by this circuit.	Only digital or discrete amplitude signals can be processed by this circuit
Sine waves are used to create the analog signals.	Square waves with amplitudes of "0" or "1" are used to create digital signals.
signal's amplitude might be both positive and negative.	The signal's amplitude is solely positive.

The To process data, they don't need a clock signal.	To synchronize digital circuitry, they largely rely on a clock signal.
It saves the data in the shape of a wave.	It saves data in a binary format known as bits (1 or 0).

4. Types of Digital Circuits (3 Marks)

4.1 Combinational Circuits

A Combinational Circuit is made up of logic gates whose outputs are decided at any one time only by the current combination of inputs, with no regard for previous inputs. Adder, Subtractor, Converter, and other combinational circuits are examples.

Use of sequential circuits:

- Calculators, digital measuring tools, computers, and other electronic devices all require combinational circuits.
- Parallel to serial convertors, data routing, and serial to parallel converters are all examples of applications for combinational logic circuits as data transmission circuits.
- Binary to gray code conversion, Gray to Binary conversion, BCD to Excess-3 conversion, and seven segment display are examples of applications for combinational logic circuits as code converter circuits.

Construction/Design of combinational circuits:

The procedures outlined below demonstrate how a combinational logic system is designed.

- Identifying the required number of input and output variables
- Symbolizing all input and output variables
- Expressing the link between these variables
- Create a truth table based on this relationship.
- For each output, evaluate the Boolean expression.
- Reduce the complexity of the Boolean expression by minimizing it.
- Use Boolean expressions to design the logic diagram.

4.2 Sequential Circuits

The output of a sequential circuit is determined by the current value of the input signal as well as the sequence of previous inputs. A sequential circuit combines the functions of a combinational circuit with the addition of a storage element. Flip-flops, registers, counters, and clocks are examples of sequential circuits.

Uses of combinational circuits:

The principal application of these circuits is to build up the memory unit, as the definition of the sequential circuit itself states that they work on memory elements. The sequential circuit must be used in anything from a little memory card to a large computer memory.

Sequential logic circuits have a wide range of applications, including:

- Shift registers
- Flip flops
- Analog to digital and digital to analog converters
- Counters
- Clocks
- Used to store temporary data in microprocessors and controllers as registers.

Construction/Design of sequential circuits:

The procedures below describe how a sequential logic system is designed:

- Assign state vectors to states, which is the state assignment problem
- Create the transition table
- Choose a flip-flop type for each state variable and generate an excitation table using the flip-flop's tables.
- From the excitation table, derive excitation and output equations.
- From the excitation and output equations, construct a logic diagram.

4.3 **Difference between Combinational and Sequential Circuits**

Combinational circuit	Sequential circuit
The output of a combinational circuit is independent of time and is only based on the input available at the moment.	On the other hand, a sequential circuit is one in which the output is dependent not only on the current input but also on the prior output.
Because the output of a combinational circuit is independent of time, no feedback is necessary for the next generation of output.	In the case of a sequential circuit, however, the output is dependent on the prior feedback, thus the output of the previous input is utilized as feedback with the input for the next output generation.
Combinational circuits are speedier and have greater performance than Sequential circuits since they just require the input of current moment.	Sequential circuits, on the other hand, are sluggish and perform worse when compared to Combinational circuits.
In comparison to sequential circuits, a combinational circuit with no feedback is less complex.	On the other hand, adding feedback to a sequential circuit makes it more complex than a simple sequential circuit.
Logic gates are the basic building blocks of combinational circuits.	Flip flops, on the other hand, are building blocks for sequential circuits.

5. Description of the main idea in your project: **(3 Marks)**

5.1 What do you want to design?

Using XOR and NOR gates, create a basic safety box circuit. The circuit shows how XOR gates may be used as bit comparators. It will unlock the safe if both of the combinations are the same. The safe will not unlock if the input and specified passwords do not match.

5.2 The most common device that will be used in your project.

The most common devices that are going to be used in our project are:

- XOR Gate
- NOR Gate
- Resistors
- LED

Disruption:

This circuit demonstrates the use of XOR gates as a bit comparator. Four XOR gates compare the bits of two four-bit binary values that are "entered" into the circuit through a series of switches. If the two numbers match bit for bit when the "Enter" pushbutton switch is pressed, the green "Go" LED will light up. If the two numbers do not match perfectly when the "Enter" pushbutton is pressed, the red "No go" LED will illuminate.

6. Design Steps **(5 Marks)**

Key Code Changes and Four Data Input Changes are depicted in the diagram, with Key Code switches labeled K0, K1, K2, and K3, and Data Changes labeled D0, D1, D2, and D3.Therefore, the results of the four XOR GATES are (K0 xor D0), (K1 xor D1), (K2 xor D2), (K3 xor D3) respectively.

Then, they are all connected by diode configuration to a single signal, so, now, this would be equal to the output of all four XOR gates, let's call this signal **output**.

Output = (K0 xor D0) or (K1 xor D1) or (K2 xor D2) or (K3 xor D3)

This is then inserted into both NOR GATE input and one input to another NOR GATE (Nor1) which will convert this signal to exit output to invert it and is fed to another NOR gate (Nor11) where single input is ~ output and the other input is the ENTER denial, i.e. ~ ENTER, the output is No go, therefore, No go = (~ output or ~ ENTER)', and your other input is connected to the ENTER input switch, When ENTER is down, the input is connected to Vdd also if ENTER is high, input is strengthened, therefore, we can say another input for ENTER denial, i.e. ~ ENTER. Therefore, its exit Go = (output or ~ ENTER)

Truth table:

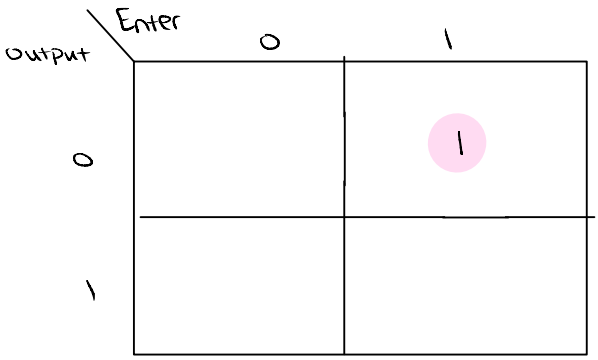
Data entry	Key entry	Date entry **XOR** Key Entry	Output (XOR)’
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

Output from XOR	Enter	**NOR**	**(NOR)’**
0	0	1	0
0	1	0	1
1	0	0	1
1	1	0	1

Go= (output + Enter’)’ = Output' * Enter

No G0= (output’ + Enter’)’ = output * Enter

K-Map for Go:



Minterms: $G_{10} = \Sigma m(2)$

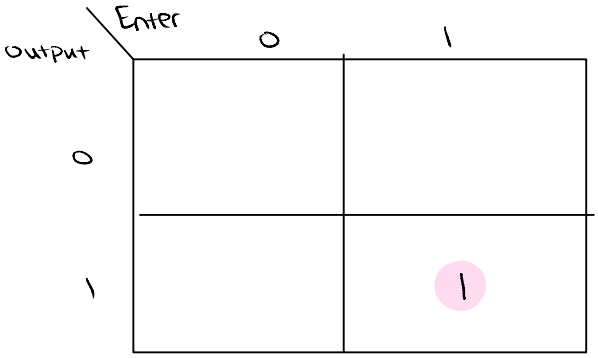
$= 10$

$=$ Enter . output'

$=$ output' . Enter

Go= output’ * Enter Simplified

K-Map for NoGo:



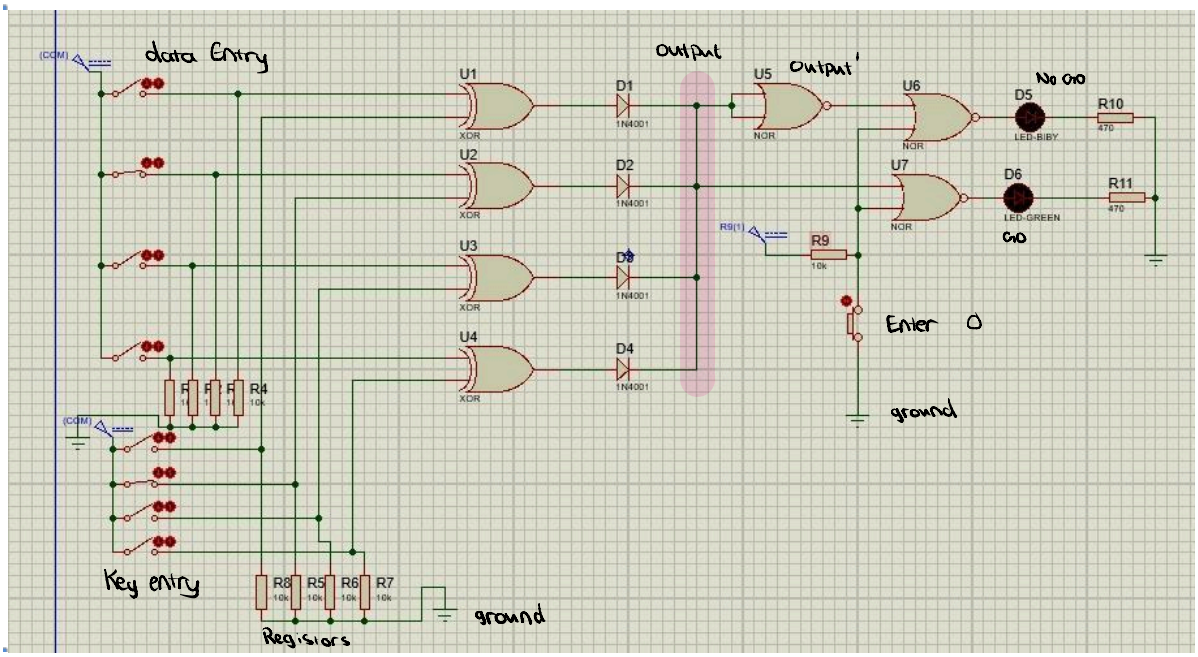
Minterms: $NoGo = \Sigma m(3)$

$= 11$

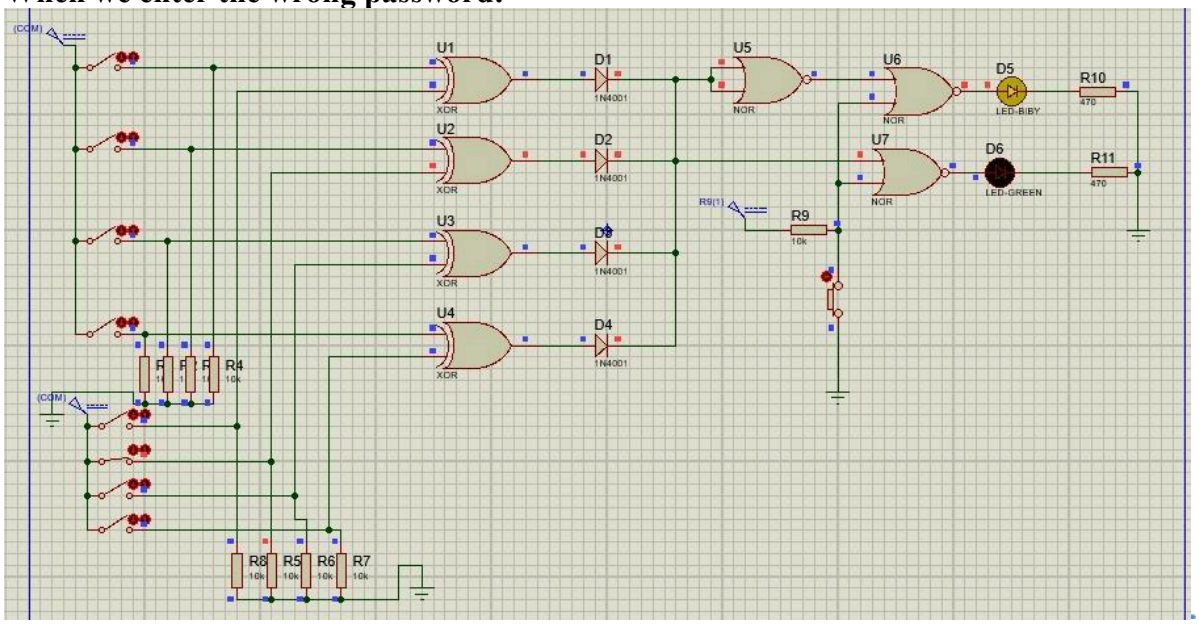
$=$ output*Enter

No Go = output*Enter Simplified

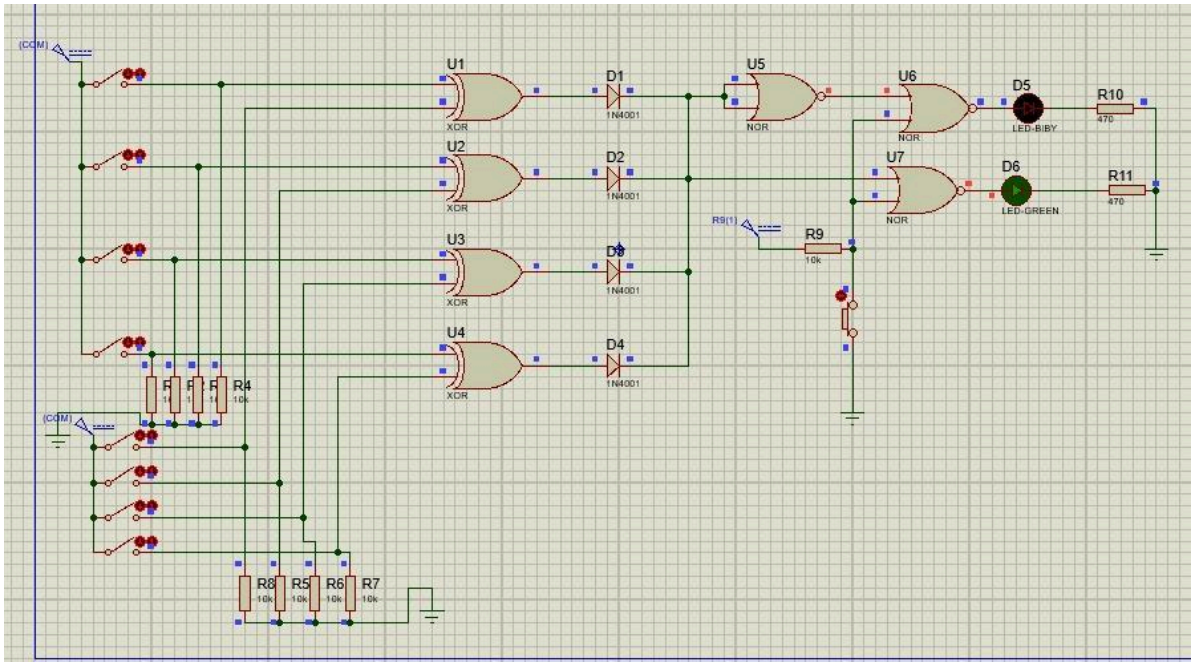
7. Circuit Layout Original circuit: (5 Marks)



When we enter the wrong password:



When we enter the Right password:



8. Bibliography

https://www.elprocus.com/difference-between-analog-circuit-and-digital-circuit/
https://sites.pitt.edu/~kmram/0132/lectures/sequential-circuit-design.pdf https://electronics-course.com/combinational-logic-design

Important Instructions:

1. Use Times New Roman Size 12 font for the text.
2. Write the report in your **own correct sentences**.
3. Do not just copy and paste from some book or website.
4. Do not cheat others.
5. Verbal discussion will be conducted individually.
6. **Project Submission:Upload a zipped folder contains:**

Final Project Report + CEDAR files via Blackboard.

Due date: Tuesday ,16 –November-2021 ,11:59 PM**. Late submission will not be accepted.**

Good Luck