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Department of Computer Science and Engineering

19ECE204 Digital Electronics and Systems

Assignment - 1

Roll No: CB.EN.U4CSE22031

Roll No: CB.EN.U4CSE22001

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Name: **ABISHEK E**

Date: 13/12/2023

Problem Statement:

Design and implement an interactive dual-player chess timer system that combines modular down counters (mod 10 and mod 6) with combinational circuits. The system should allow players to set their timer durations at the beginning of the game using push-button controls for minutes and seconds. The chess timer should incorporate a mechanism where a player must initiate the other player's timer after making a move and should show "OVER" to indicate the timeout.

Design:

Transition table of 74109 Dual JK Flip-Flop:

Q_n	Q_{n+1}	J	K
0	0	0	X
1	0	X	1
0	1	1	X
1	1	X	0

Key :

Q_n: Present State

Q_{n+1}:Next State

Components Required:

SNO	COMPONENTS NAME	IC NUMBER	QUANTITY
1	Dual J-K Positive Edge-Triggered Flip-Flop	IC 74109	42
2	2-Input AND	IC 7408	60
3	NOT	IC 7404	18
4	3-Input AND	IC 7411	8
5	2-Input OR	IC 7432	18
6	BCD-to-7-Segment LED Decoder	IC 4511	12
7	2-Input Multiplexer	IC 74HC157	7
8	4 input MUX	IC 74153	1
TOTAL			162

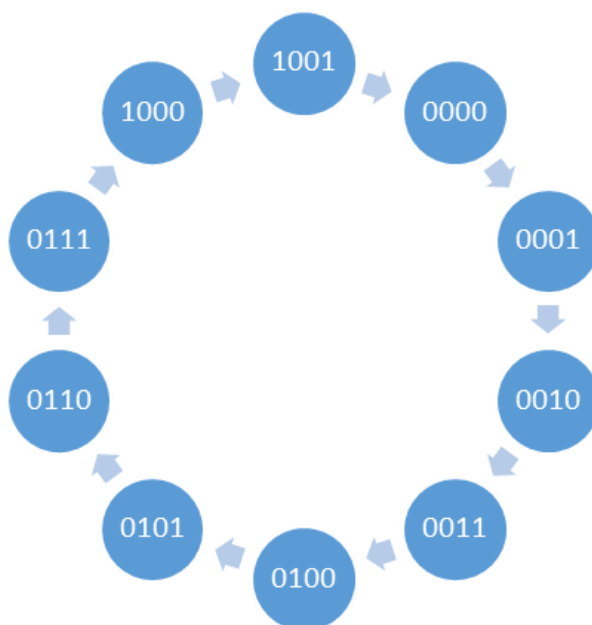
COST CALCULATION:

S.NO	IC NUMBER	QUANTITY	NO OF INPUTS	
1	IC 74109	42	2	84+42
2	IC 7408	60	2	120+60
3	IC 7404	18	1	18+18
4	IC 7411	8	3	24+8
5	IC 7432	18	2	36+18
6	IC 4511	8	4	32+8
7	IC 74HC157	8	8	64+8
8	IC 74153	1	4	4+1
		TOTAL	COST	537

Minimization Procedure:

Synchronous Mod 10 counter:

STATE DIAGRAM:



Present State

Next State

Q 3	Q 2	Q 1	Q 0
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1

[illegible]

J 3	K 3
1	X
O	X
O	X
O	X
O	X
O	X
O	X
O	X
O	X
X	1
X	O
X	X
X	X
X	X
X	X
X	X
X	X

[illegible][illegible][illegible]

Minimized Function Expression using K-Map:

f		$q1, q0$			
		00	01	11	10
$q3, q2$	00	1	0	0	0
	01	0	0	0	0
	11	-	-	-	-
	10	-	-	-	-

$$J_3 = Q_2' \cdot Q_1' \cdot Q_0'$$

f		$q1, q0$			
		00	01	11	10
$q3, q2$	00	-	-	-	-
	01	-	-	-	-
	11	-	-	-	-
	10	1	0	-	-

$$K_3 = Q_0'$$

<i>f</i>		<i>q1,q0</i>			
		00	01	11	10
<i>q3,q2</i>	00	0	0	0	0
	01	-	-	-	-
	11	-	-	-	-
	10	1	0	-	-

$$J_2 = Q_3 \cdot Q_0'$$

<i>f</i>		<i>q1,q0</i>			
		00	01	11	10
<i>q3,q2</i>	00	-	-	-	-
	01	1	0	0	0
	11	-	-	-	-
	10	-	-	-	-

$$K_2 = Q_1' \cdot Q_0'$$

f		$q1,q0$			
		00	01	11	10
$q3,q2$	00	0	0	-	-
	01	1	0	-	-
	11	-	-	-	-
	10	1	0	-	-

$$J1 = Q0' . (Q3 + Q2)$$

f		$q1,q0$			
		00	01	11	10
$q3,q2$	00	-	-	0	1
	01	-	-	0	1
	11	-	-	-	-
	10	-	-	-	-

$$K1 = Q0'$$

f		$q1,q0$			
		00	01	11	10
$q3,q2$	00	1	-	-	1
	01	1	-	-	1
	11	-	-	-	-
	10	-	-	-	-

J0 = 1

f		$q1,q0$			
		00	01	11	10
$q3,q2$	00	-	1	1	-
	01	-	1	1	-
	11	-	-	-	-
	10	-	-	-	-

K0 = 1

J ₂	K ₂
1	X
0	X
0	X
0	X
X	1
X	0
X	X
X	X

J ₁	K ₁
0	X
0	X
X	1
X	0
1	X
0	X
X	X
X	X

J ₀	K ₀
1	X
X	1
1	X
X	1
1	X
X	1
X	X
X	X

Minimized Function Expression using K-Map:

f		$q1, q0$			
		00	01	11	10
$q2$	0	1	0	0	0
	1	-	-	-	-

$$J_2 = Q_1' + Q_0'$$

f		$q1, q0$			
		00	01	11	10
$q2$	0	-	-	-	-
	1	1	0	-	-

$$K2 = Q0'$$

f		$q1, q0$			
		00	01	11	10
$q2$	0	-	-	-	-
	1	1	0	-	-

$$J1 = Q2 \cdot Q0'$$

f		$q1, q0$			
		00	01	11	10
$q2$	0	-	-	0	1
	1	-	-	-	-

$$K1 = Q0'$$

f		$q1, q0$			
		00	01	11	10
$q2$	0	1	-	-	1
	1	1	-	-	-

$J_0 = 1$

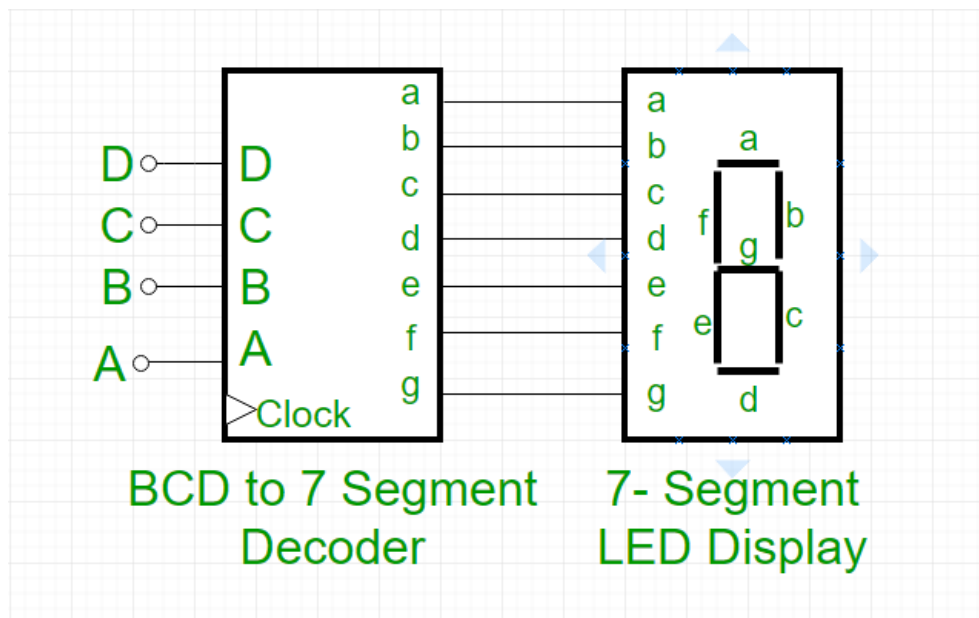
f		$q1, q0$			
		00	01	11	10
$q2$	0	-	1	1	-
	1	-	1	-	-

$K_0 = 1$

BCD to 7-Segment Decoder:

In **Binary Coded Decimal (BCD)** encoding scheme each of the decimal numbers(0-9) is represented by its equivalent binary pattern(which is generally of 4-bits).

Whereas, **Seven segment** display is an electronic device that consists of seven Light Emitting Diodes (LEDs) arranged in a definite pattern (common cathode or common anode type), which is used to display Hexadecimal numerals(in this case decimal numbers, as input is BCD i.e., 0-9).



X3	X2	X1	X0	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1

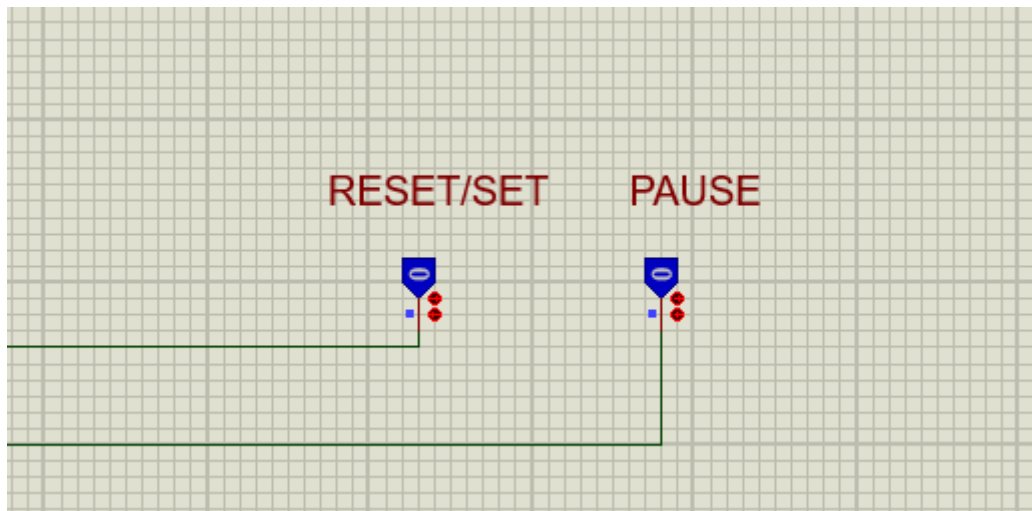
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	1	0	1	1

Working:

The chess timer system is equipped with two independent timers, each featuring a 7-segment display for clear visualization of minutes and seconds. The initialization process involves two mod 10 counters for managing the ones and tens places of the minutes and two mod 6 counters for the tenths and one's places of the seconds for both timers.

Initialization:

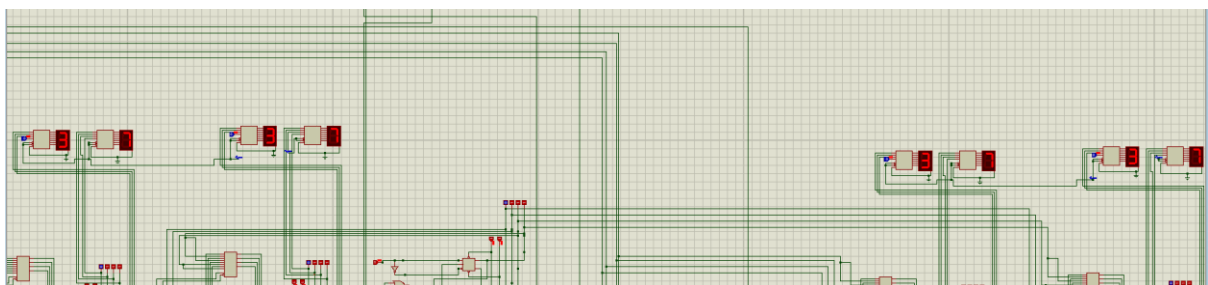
- At the beginning of the chess game, the system is powered on, and both timers are initialized to user-configured values for minutes and seconds using push buttons. These initial values represent each player's total time for the entire game.
- Before the game starts, users can set the initial timer values for minutes and seconds using push buttons. This configuration is typically a one-time setup.



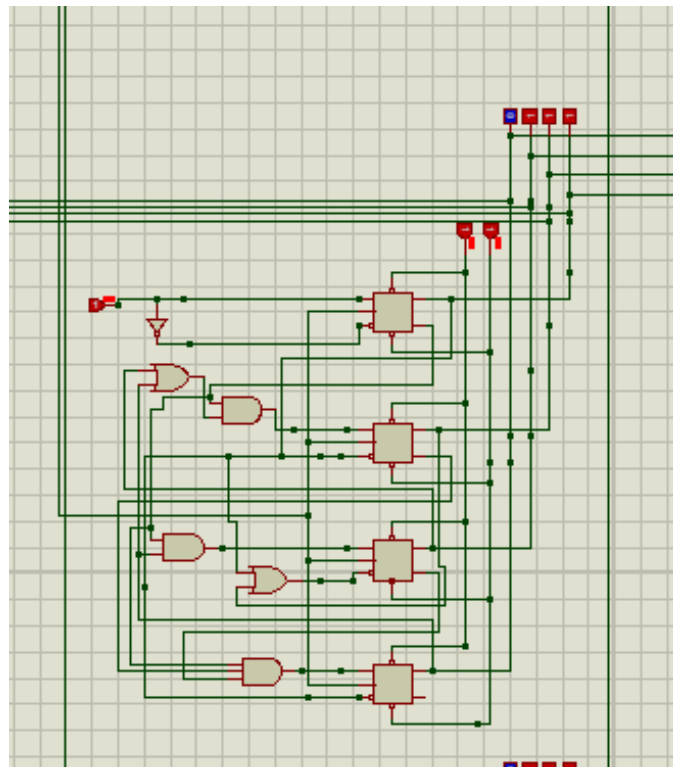
To initialize the minutes and seconds for each player, we use two mod 10 counters for the ones and tens places of the minutes, and two mod 6 counters for the tenths and ones places of the seconds. This modular setup ensures precise control over the configuration of time, with the mod 10 counters handling the tens and one's places, and the mod 6 counters handling the tenths and one's places for both minutes and seconds.

7-segment Display:

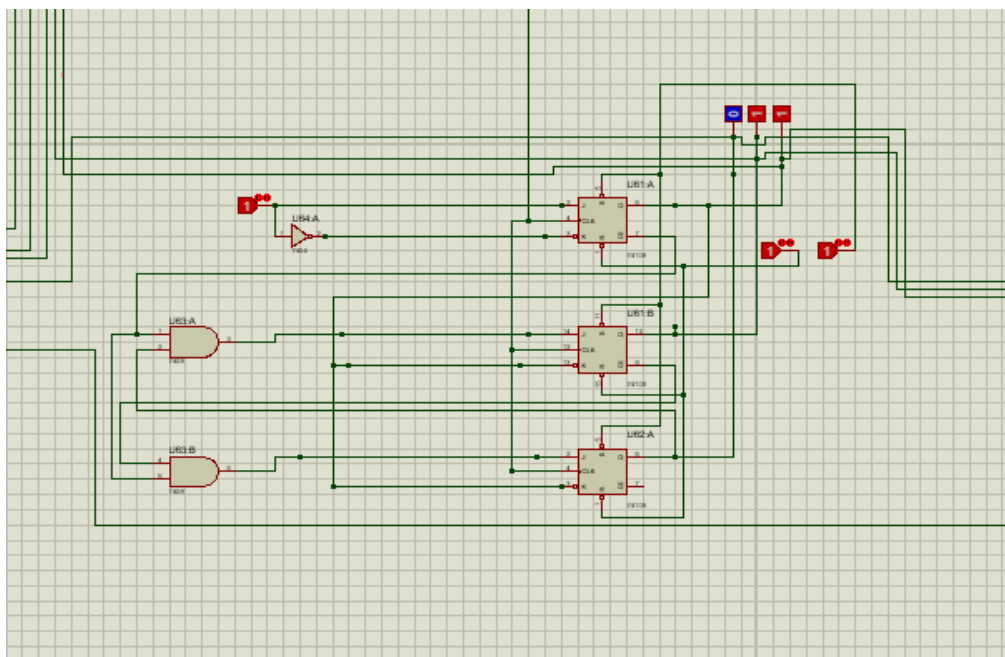
As each player initiates their timer, the countdown begins, and the remaining time is dynamically presented on the respective 7-segment display.



Mod 10 down counter:



Mod 6 down counter:



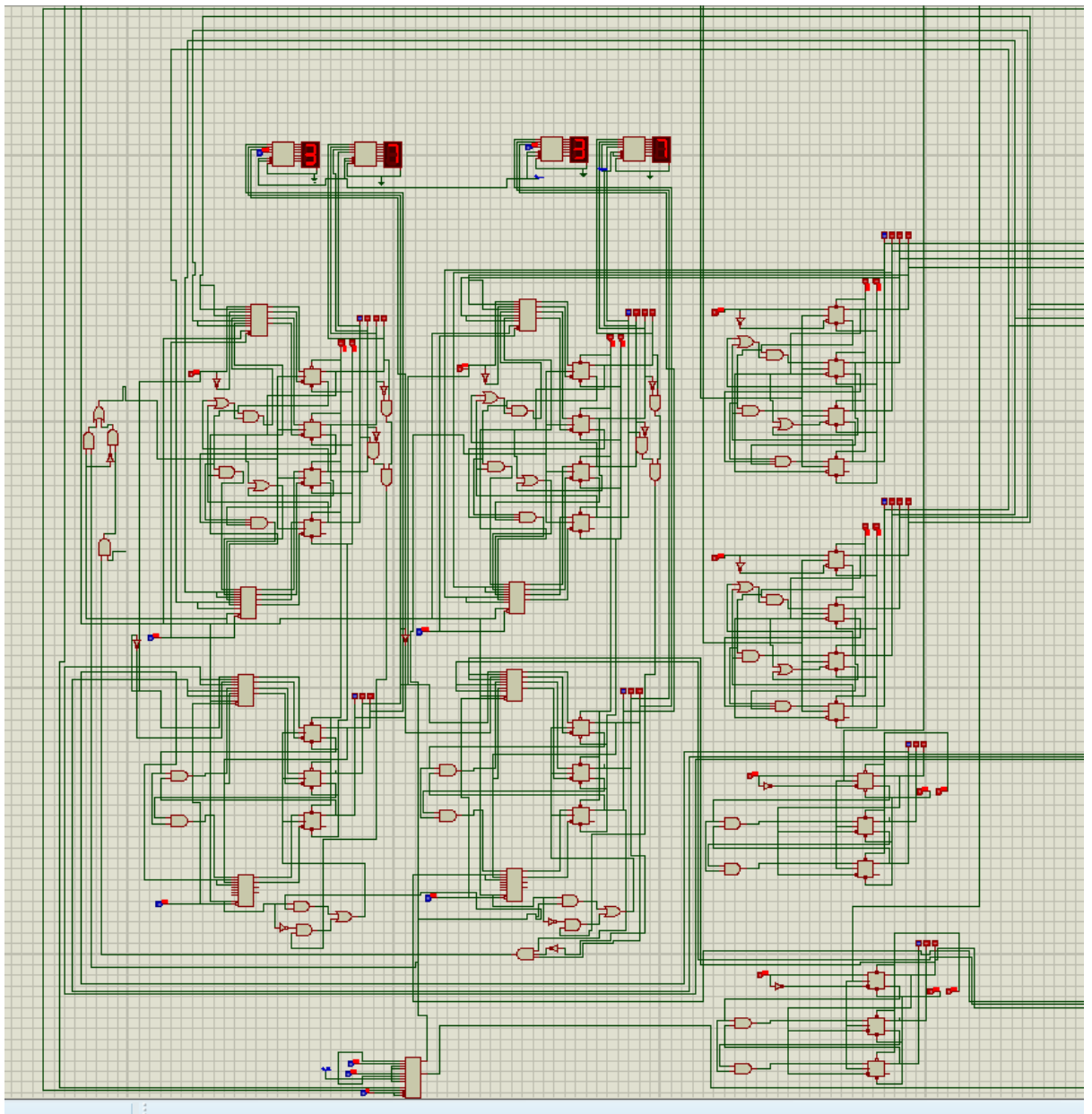
Player Interaction:

- Player A makes a move and then presses a designated button to start their timer. Simultaneously, Player B's timer remains paused.

Countdown Operation:

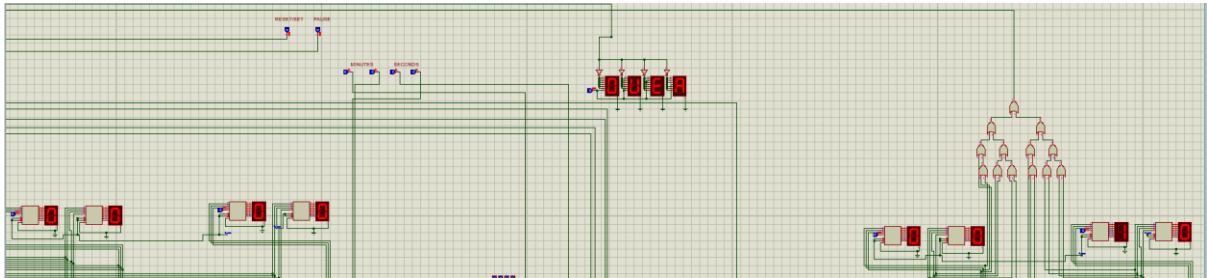
- The modular down counters (mod 10 and mod 6) are employed to create dual countdown timers for each player. These counters decrement the minutes and seconds based on the configured time.

Single Timer:



Timeout Detection:

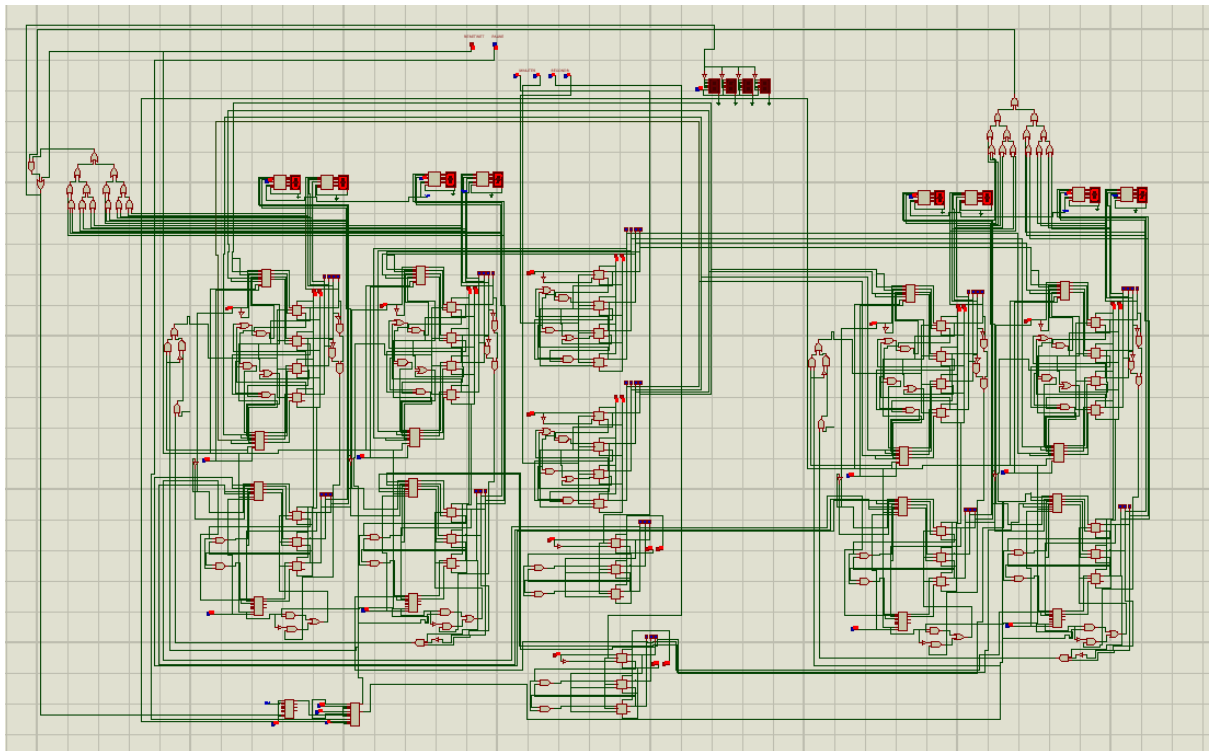
- The system continuously monitors the countdown status. When Player A's timer reaches zero, indicating a timeout, the system shows "OVER" with the help of a seven segment display.



Reset Functionality:

- Players have the option to reset the timers to their initial values using a designated reset button, typically before the game starts.

FULL CIRCUIT:



Conclusion:

In conclusion, the implemented chess timer system, featuring down counters, 7-segment displays, pause, reset, and parallel loading functionalities, excels in providing a comprehensive solution for precise timekeeping. The down counters efficiently manage countdowns, while 7-segment displays offer clear visual feedback. Pause and reset functions enhance user control, ensuring flexibility during gameplay. Additionally, the parallel loading functionality allows users to set initial time values, contributing to the overall versatility and user-friendly design of the chess timer system.