KULLIYYAH OF ENGINEERING
DEPARTMENT OF MECHATRONICS

MCTE 2332
DIGITAL SYSTEMS AND MICROPROCESSORS
SECTION 1

"DIGITAL SYSTEMS FINAL PROJECT"
(TIMED TRAFFIC LIGHT SYSTEM)

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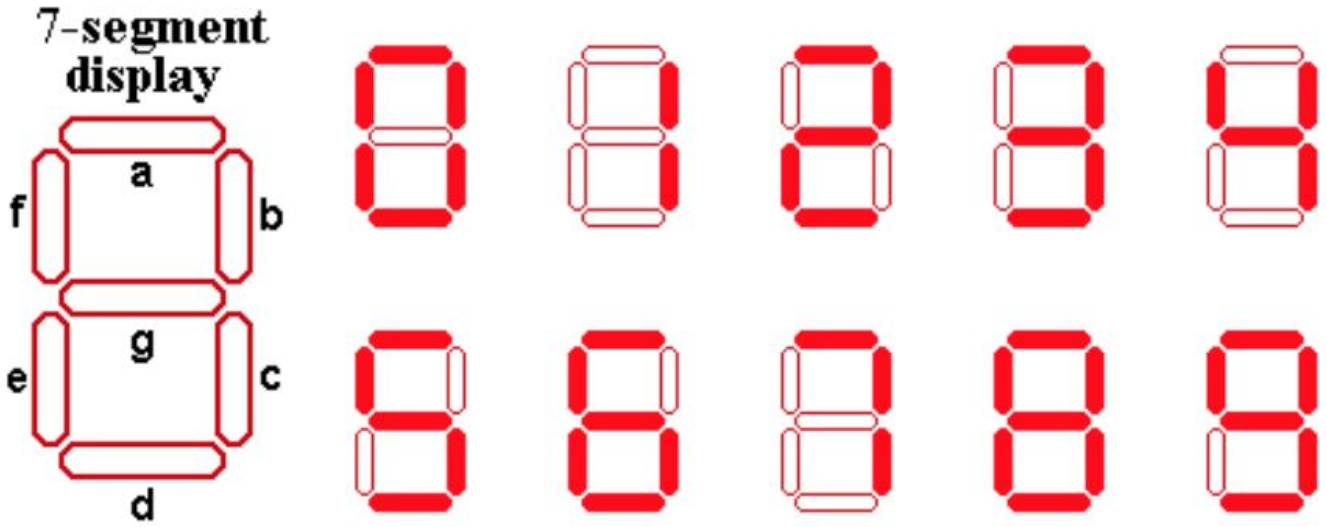
GOAL OF THE PROJECT

The goal of this project is to design a fully functional digital system that represents the working principle of a timed traffic light signal. The main purpose of a traffic light is to manage the motion of traffic at every street or intersection allowing drivers or pedestrians to cross the road safely. The design consists of a 7-segment display, decade counter, 3 LEDs, T flip-flops, and a number of NAND gates. The 7-segment display is connected to a 4-bit asynchronous up decade counter to represent the timing mechanism between each light switch of the traffic light, meaning that after every 10 seconds the traffic light switches from red to green and vice versa.

DESIGN PROCESS

First the 7-segment display circuit is constructed using logisim combinational analysis option where it will construct a working digital circuit depending on the input and output variables, next the table containing the variables is filled with the relevant values for the design. The circuit is constructed using universal NAND gates only for the design simplicity. After the 7-segment display circuit has been constructed, a 4-bit decade counter circuit is connected to its input in order to control the flow of the display output. The counter is made up of 4 T flip-flops connected asynchronously to create a ripple counter that feeds into the main circuit. whenever the output of the counter is equal to 1001 (9 in decimal) it resets back to zero thus making it suitable to be used with the 7-segment display. Next, the 7-segment display is connected to the circuit. After that, the traffic light LEDs are set in place and connected to the counter via a T flip-flop. whenever the count is 1000 (8 in decimal) the yellow LED lights up indicating that the traffic light is about to switch color. then the red and green LEDs are connected to the T flip-flop which toggles between the two colors whenever the count is at 1001 (9 in decimal).
The 7-segment display is constructed according to this diagram:



DETAILED DESIGN

7-Segment Display

Truth Table

Counter Input				Circuit outputs							7-Segment Display Output (in Decimal)
D	C	B	A	a	b	c	d	e	f	g	
0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	1	0	1	1	0	0	0	0	1
0	0	1	0	1	1	0	1	1	0	1	2
0	0	1	1	1	1	1	1	0	0	1	3
0	1	0	0	0	1	1	0	0	1	1	4
0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	0	1	1	1	1	1	6
0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	1	1	1	1	0	1	1	9

a = B'D' + C + BD + A

b = B' + C' D' + CD

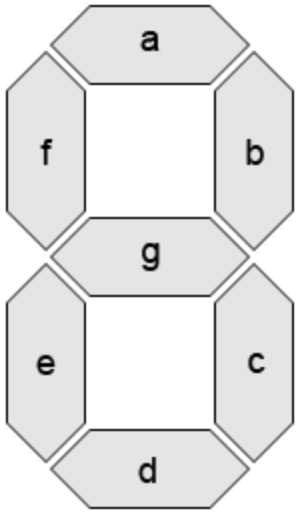
c = C' + D + B

d = B'D' + B'C + CD' + BC'D + A

e = B'D' + CD'

f = C'D' + BC' + BD' + A

g = B'C + BC' + BD' + A



K-maps

a		CD			
		00	**01**	**11**	**10**
A B	**00**	1	0	1	1
	01	0	1	1	1
	11	x	x	x	x
	10	1	1	x	x

a = B'D' + C + BD + A

b		CD			
		00	**01**	**11**	**10**
A	**00**	1	1	1	1
	01	1	0	1	0
B	**11**	x	x	x	x
	10	1	1	x	x

b = B’ + C’ D’ + CD

c		CD			
		00	**01**	**11**	**10**
A	**00**	1	1	1	0
	01	1	1	1	1
B	**11**	x	x	x	x
	10	1	1	x	x

c = C’ + D + B

d		CD			
		00	**01**	**11**	**10**
A	**00**	1	0	1	1
	01	0	1	0	1
B	**11**	x	x	x	x
	10	1	1	x	x

d = B’D’ + B’C + CD’ + BC’D + A

e		CD			
		00	**01**	**11**	**10**
A	**00**	1	0	0	1
	01	0	0	0	1
B	**11**	x	x	x	x
	10	1	0	x	x

e = B’D’ + CD’

f		CD			
		00	**01**	**11**	**10**
A **B**	**00**	1	0	0	0
	01	1	1	0	1
	11	x	x	x	x
	10	1	1	x	x

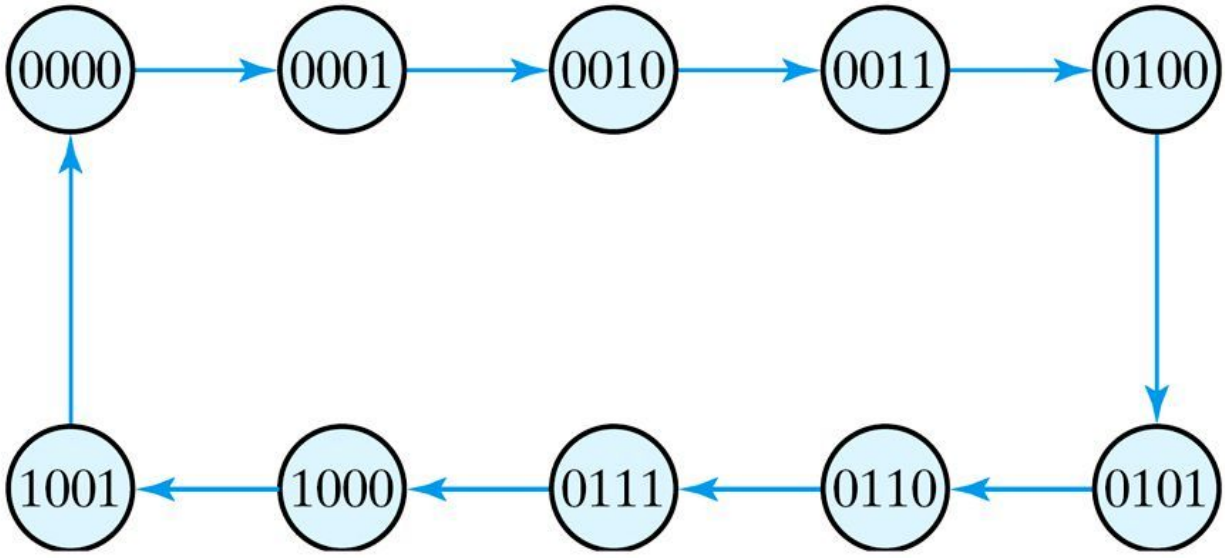
f = C'D' + BC' + BD' + A

g		CD			
		00	**01**	**11**	**10**
A **B**	**00**	0	0	1	1
	01	1	1	0	1
	11	x	x	x	x
	10	1	1	x	x

g = B'C + BC' + BD' + A

4-bit Decade Asynchronous Counter

State diagram



Truth table

T Flip-Flops Output (count)					Decimal Equivalent (Display output)
T4	**T3**	**T2**	**T1**		
0	0	0	0		0
0	0	0	1		1
0	0	1	0		2
0	0	1	1		3
0	1	0	0		4
0	1	0	1		5
0	1	1	0		6
0	1	1	1		7
1	0	0	0		8
1	0	0	1		9

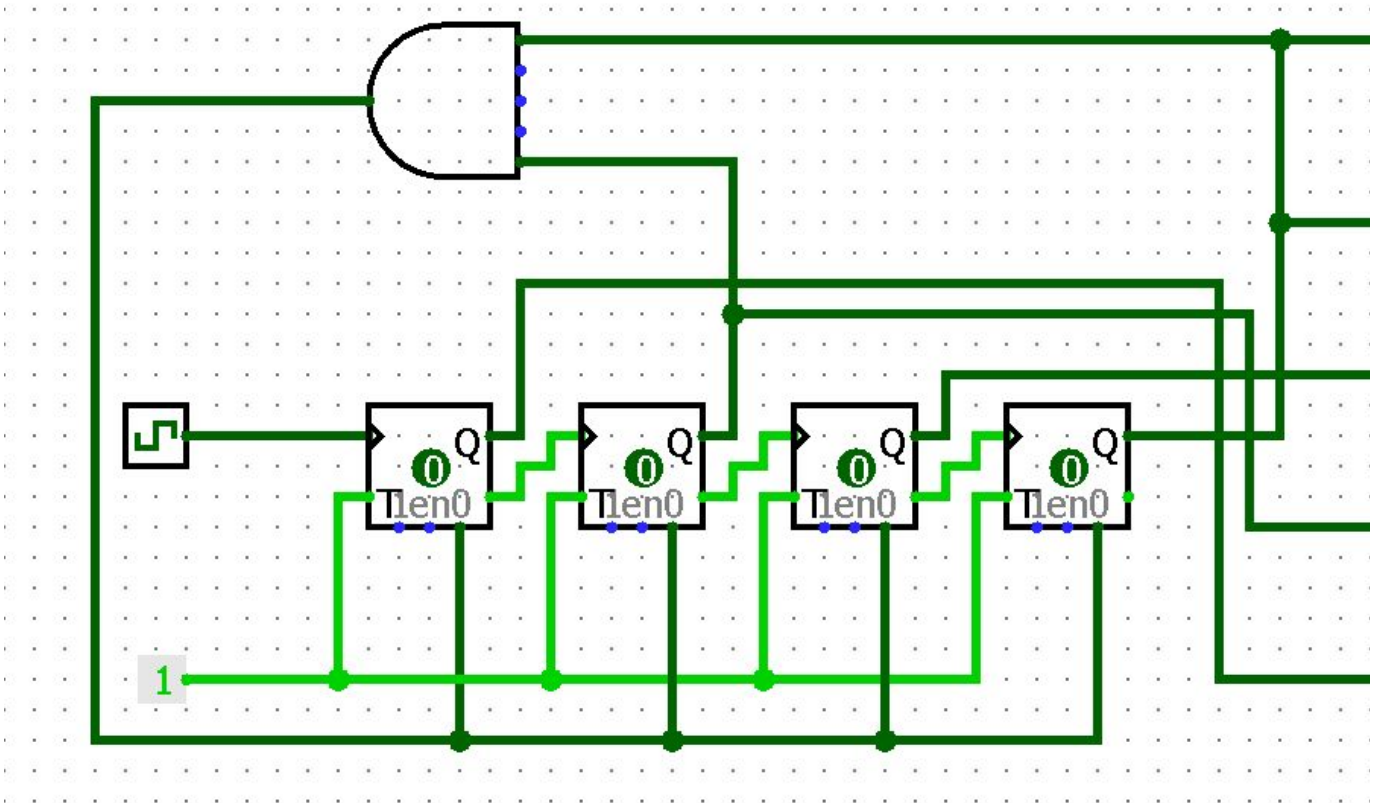
⟶ For the T Flip-Flop controlling the Traffic Light (T5):

T5 = T1 + T4

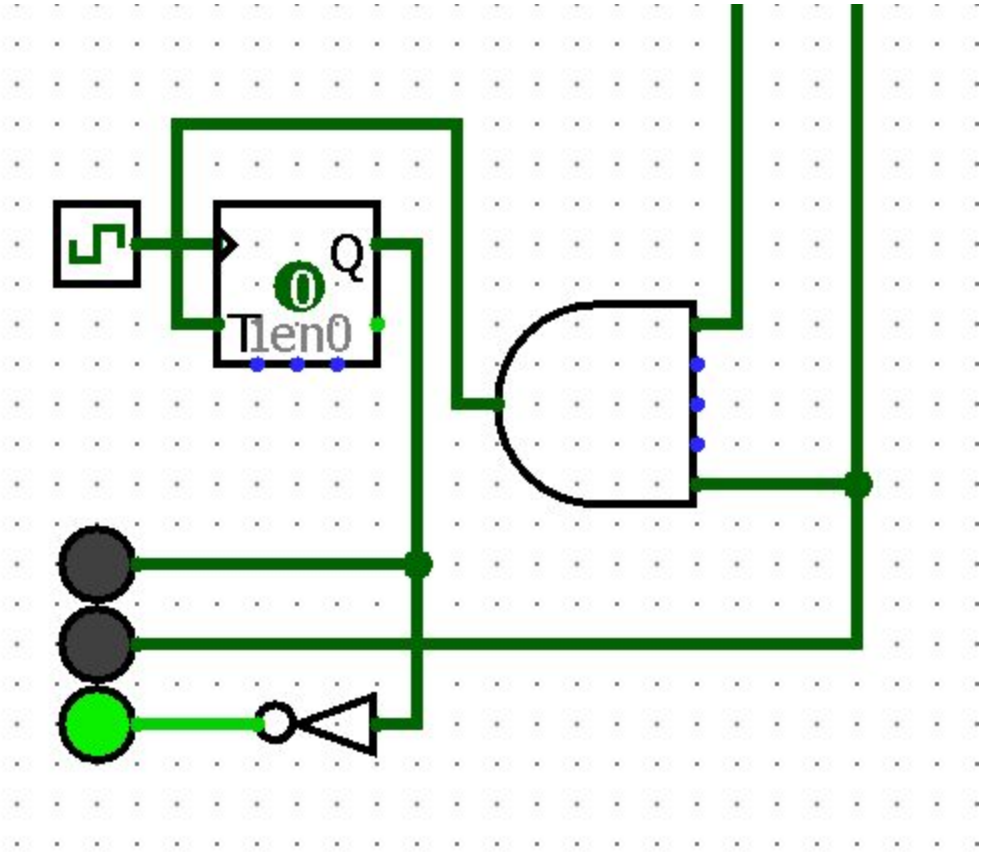
T1	**T4**	**T5**
0	0	No change
0	1	No change
1	0	No change
1	1	Toggle

CIRCUIT DESIGN

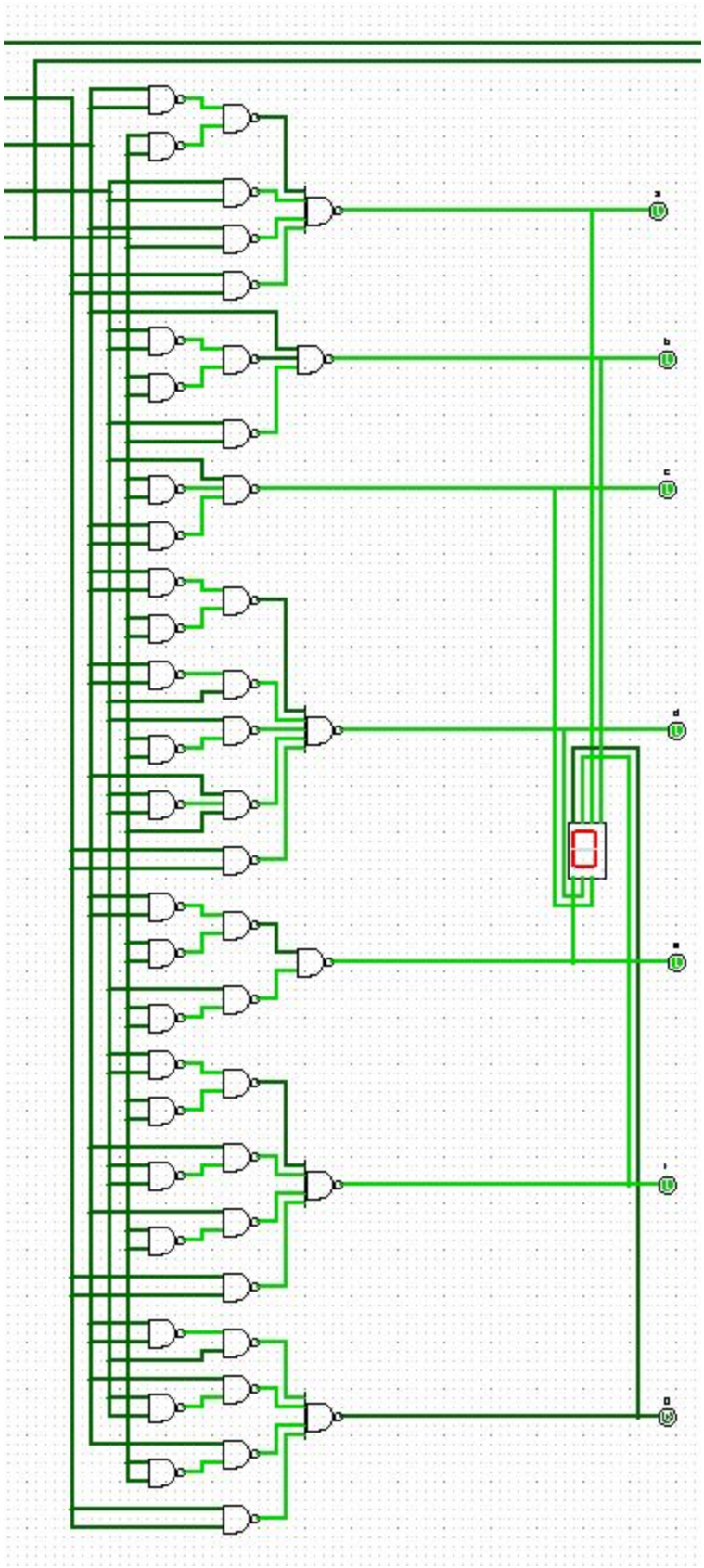
Counter Circuit



Traffic Light Circuit



7-Segment Display Circuit



CONCLUSION

We can conclude that digital systems have had an undeniable impact on our lives from so many various aspects, from computers and microprocessors to a simple calculator or a traffic light system. It is crucial for us as engineers to keep improving upon past knowledge and building on it, in order to lead our human development to higher stages and pioneer in our way using the power of problem solving.
The main goal of this project has been fulfilled, which is to design and implement a digital traffic light system using the knowledge that was acquired through the study of digital systems.