DIGITAL ELECTRONICS AND LOGIC DESIGN [EC - 207]

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BCD TO EXCESS-3 AND EXCESS-3 TO BCD CONVERTOR

AIM: To design and implement BCD to EXCESS -3 code converter using Multi-sim.

SOFTWARE TOOLS / OTHER REQUIREMENTS:

(1) Multisim Simulator.

THEORY:

The Excess-3 binary code is an example of a self-complementary BCD code. A self-complementary binary code is a code which is always complimented in itself. By replacing the bit 0 to 1 and 1 to 0 of a number, we find the 1's complement of the number. The sum of the 1'st complement and the binary number of a decimal is equal to the binary number of decimal 9.

The process of converting BCD to Excess-3 is quite simple from other conversions. The Excess-3 code can be calculated by adding 3, i.e., 0011 to each four-digit BCD code. Below is the truth table for the conversion of BCD to Excess-3 code. In the below table, the variables A, B, C, and D represent the bits of the binary

numbers. The variable 'D' represents the LSB, and the variable 'A' represents the MSB. In the same way, the variables w, x, y, and z represent the bits of the Excess-3 code. The variable 'z' represents the LSB, and the variable 'w' represents the MSB. The 'don't care conditions' is expressed by the variable 'X'.

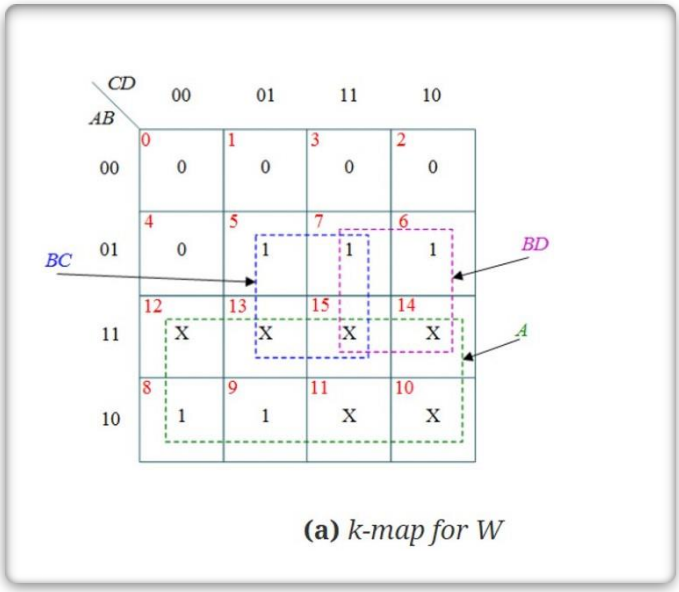
The BCD (binary coded decimal) code is basically 8421 code and the conversion of 4-bit input BCD code ($A\ B\ C\ D$) into the excess-3 code output ($W\ X\ Y\ Z$) as shown in truth table 1.

Truth Table - 1

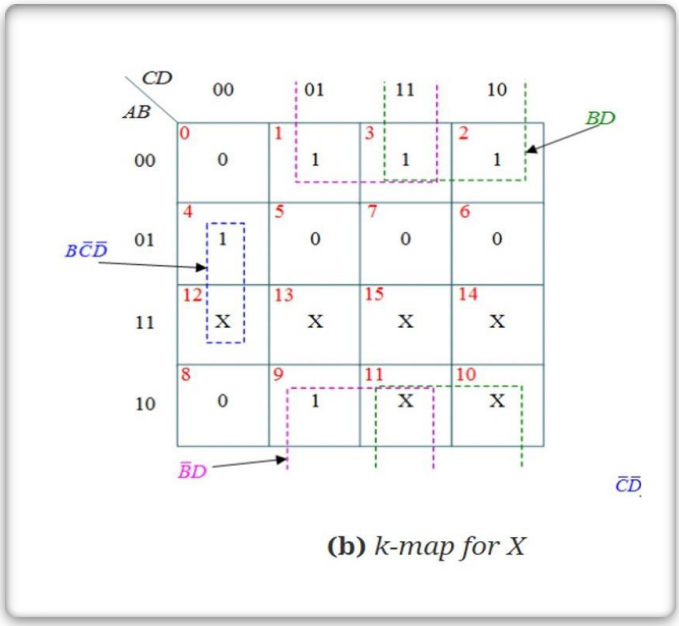
BCD Code (Input)				Excess-3 Code (Output)			
A	*B*	*C*	*D*	*W*	*X*	*Y*	*Z*
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0
1	0	1	0	X	X	X	X
1	0	1	1	X	X	X	X
1	1	0	0	X	X	X	X
1	1	0	1	X	X	X	X
1	1	1	0	X	X	X	X
1	1	1	1	X	X	X	X

Drawing of K-map for each output

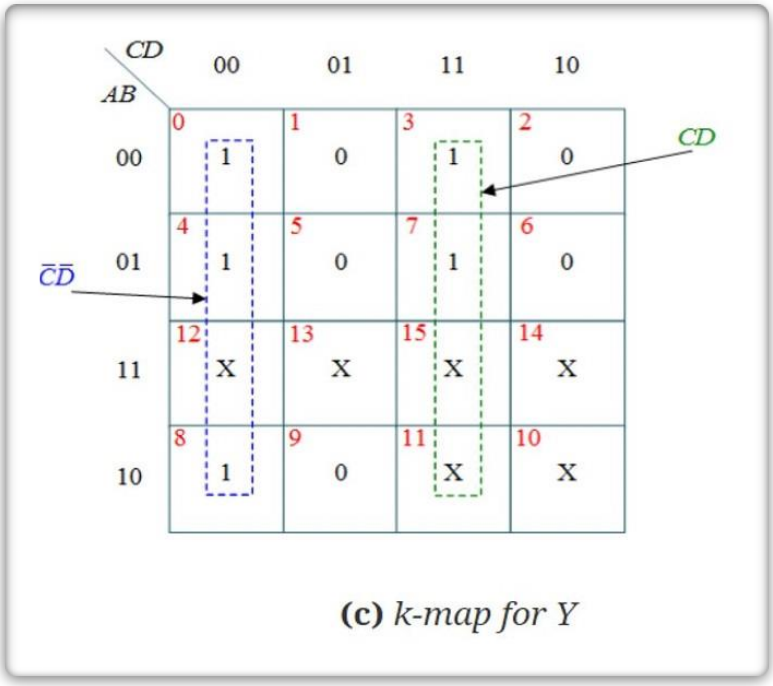
From this truth table, the K-maps are drawing shown in Figure 1, to obtain a minimized expression for each output.



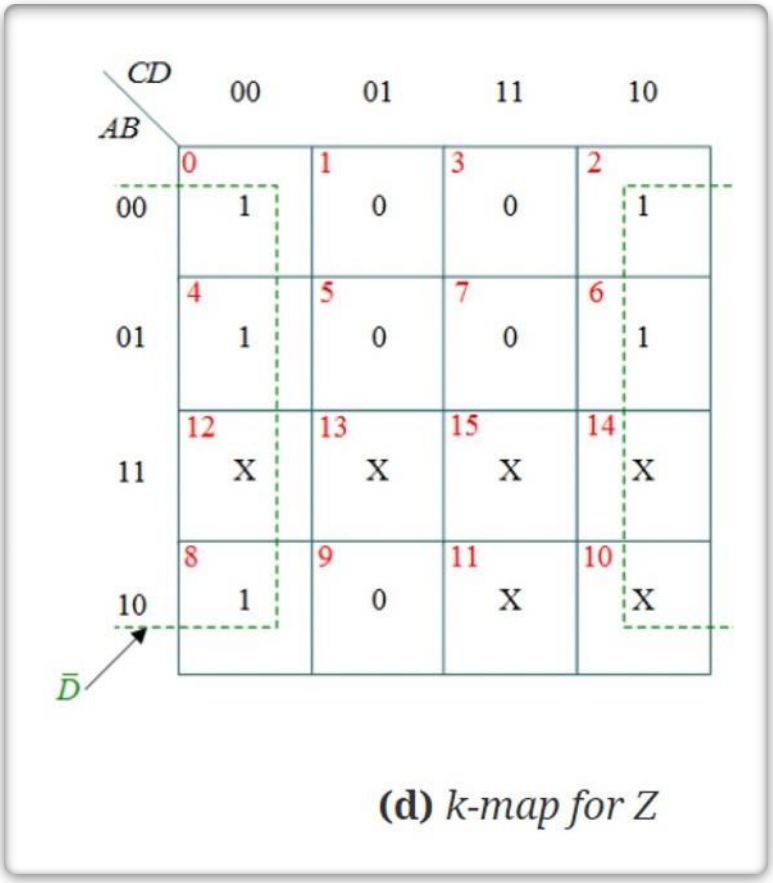
(a) *k-map for W*



(b) *k-map for X*



(c) *k-map for Y*



(d) *k-map for Z*

Minimized Version of Output :-

w=A+BC+BD
x=B' C+B' D+BC' D'
y=CD+C'D'
z=D'

LOGIC CIRCUIT DIAGRAM

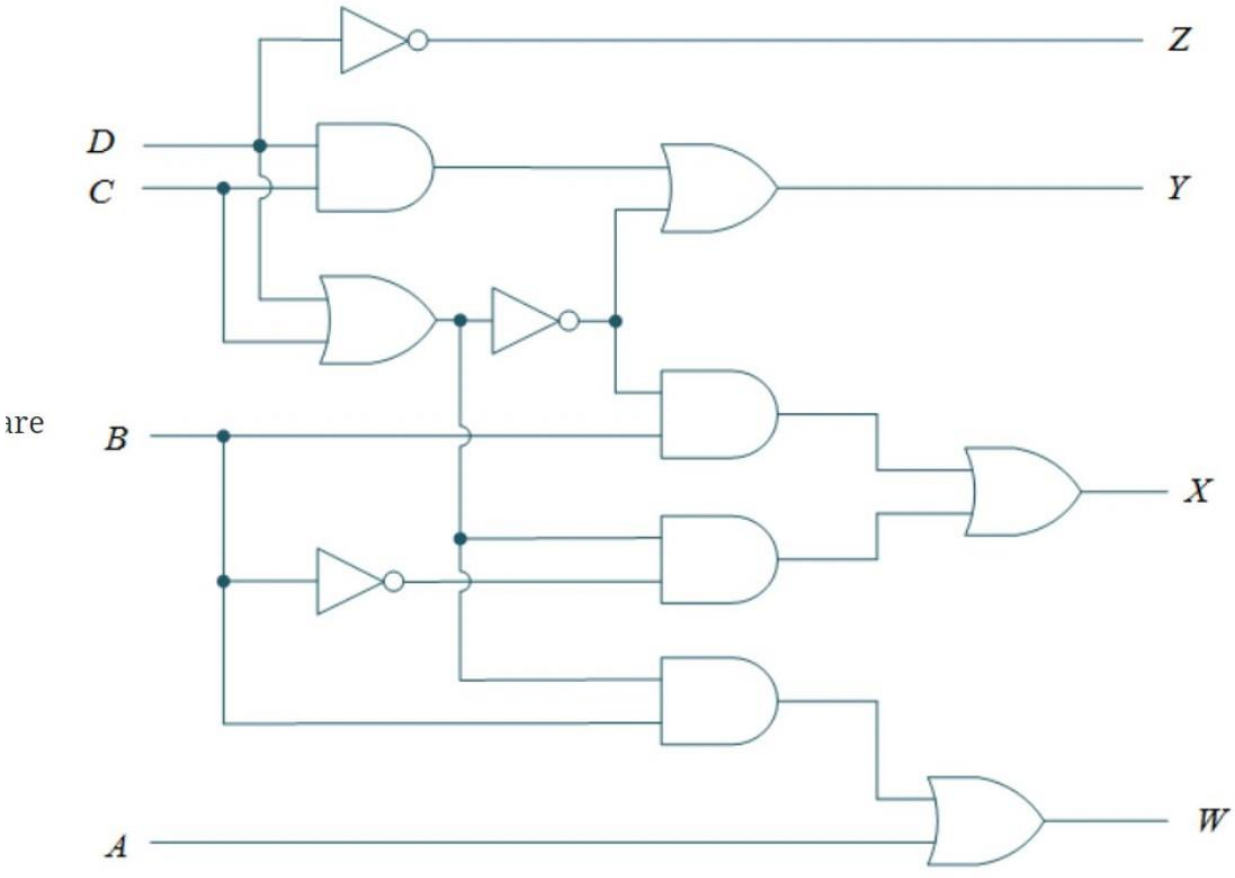


Figure 2: *BCD to Excess-3 Code Converter logic diagram.*

Excess-3 to BCD conversion: -

The process of converting Excess-3 to BCD is opposite to the process of converting BCD to Excess-3. The BCD code can be calculated by subtracting 3, i.e., 0011 from each four-digit Excess-3 code. Below is the truth table for the conversion of Excess-3 code

Truth Table - 2

EXCESS-3 INPUT				BCD OUTPUT			
E3	E2	E1	E0	B3	B2	B1	B0
0	0	0	0	X	X	X	X
0	0	0	1	X	X	X	X
0	0	1	0	X	X	X	X
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	1
0	1	0	1	0	0	1	0
0	1	1	0	0	0	1	1
0	1	1	1	0	1	0	0
1	0	0	0	0	1	0	1
1	0	0	1	0	1	1	0
1	0	1	0	0	1	1	1
1	0	1	1	1	0	0	0
1	1	0	0	1	0	0	1
1	1	0	1	X	X	X	X
1	1	1	0	X	X	X	X
1	1	1	1	X	X	X	X

to BCD. In the below table, the variables w, x, y, and z represent the bits of the Excess-3 code. The variable 'z' represents the LSB, and the variable 'w' represents the MSB. In the same way, the variables A, B, C, and D represent the bits of the binary numbers. The variable 'D' represents the LSB, and the variable 'A' represents the MSB. The 'don't care conditions' is defined by the variable ‘X'.

Now, we will use the K-map method to design the logical circuit for the conversion of BCD to Excess-3 code as:

K-map for B3:

E3E2 \ E1E0	00	01	11	10
00	X	X	0	X
01	0	0	0	0
11	1	X	X	X
10	0	0	1	0

$B3 = ((E0E1) + E2)\,E3$

K-map for B2:

E3E2 \ E1E0	00	01	11	10
00	X	X	0	X
01	0	0	1	0
11	0	X	X	X
10	1	1	0	1

$B2 = \overline{E2}E1 + \overline{E2}E0 + E2E1E0$

K-map for B1:

E3E2 \ E1E0	00	01	11	10
00	X	X	0	X
01	0	1	X	1
11	0	X	X	X
10	X	1	0	1

$B1 = E1 \oplus E0$

K-map for B0:

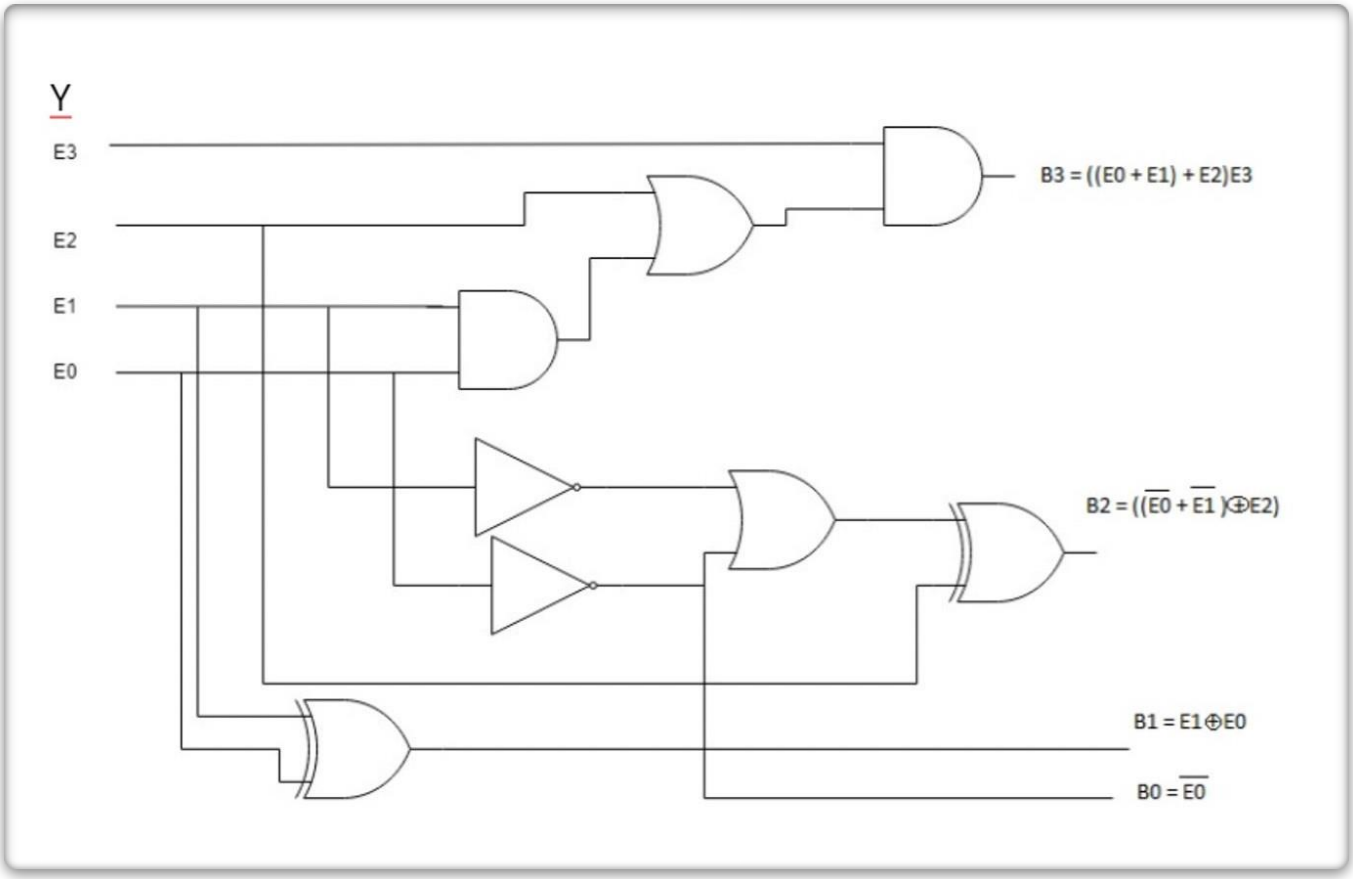
E3E2 \ E1E0	00	01	11	10
00	X	X	0	X
01	1	0	0	1
11	1	X	X	X
10	1	0	0	1

$B0 = \overline{E0}$

Minimized Version of Output :-

w=AB+ACD
B=x' y'+x' z'+xyz
C=y' z+yz'
D=z'

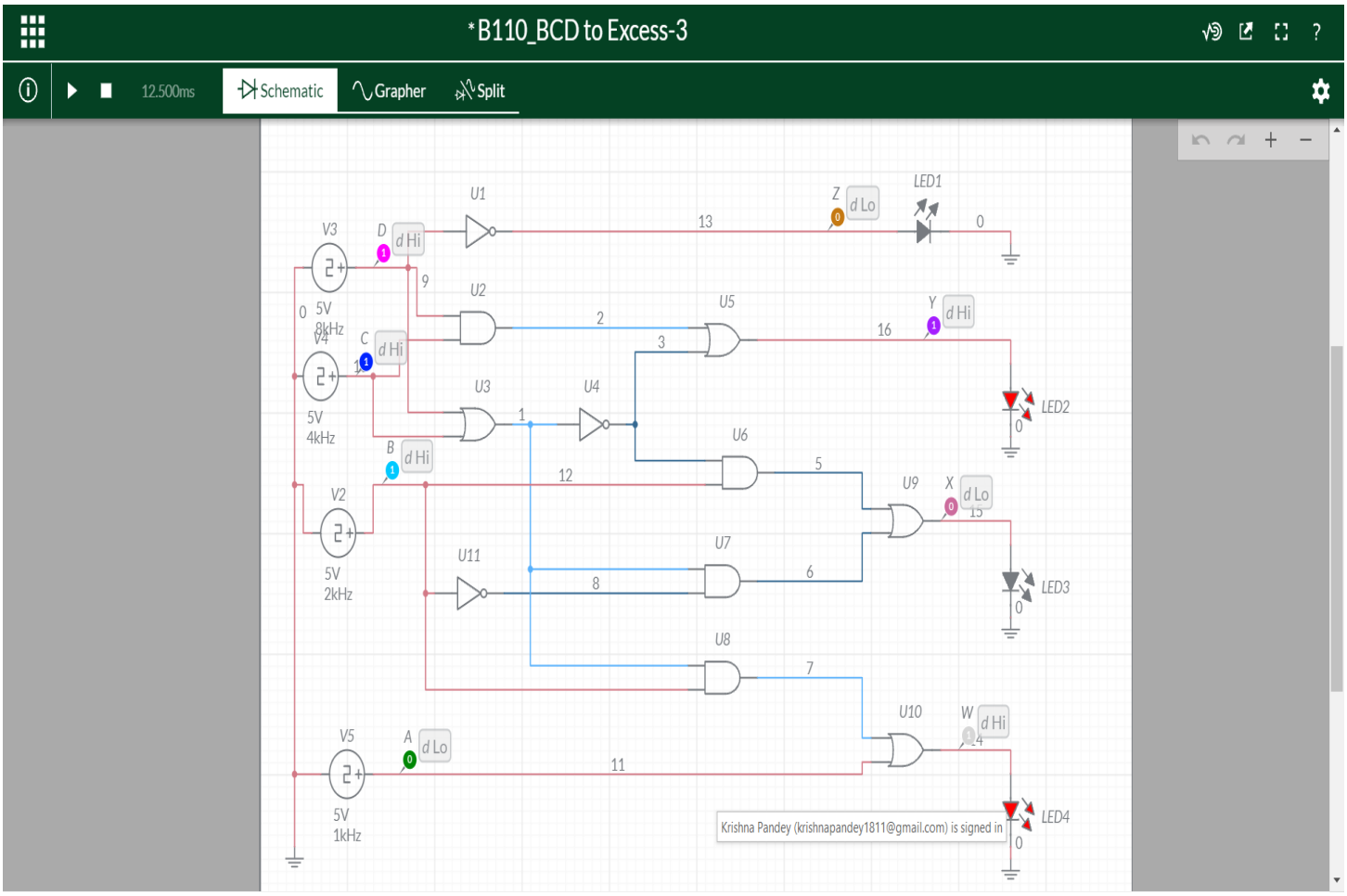
LOGIC CIRCUIT DIAGRAM



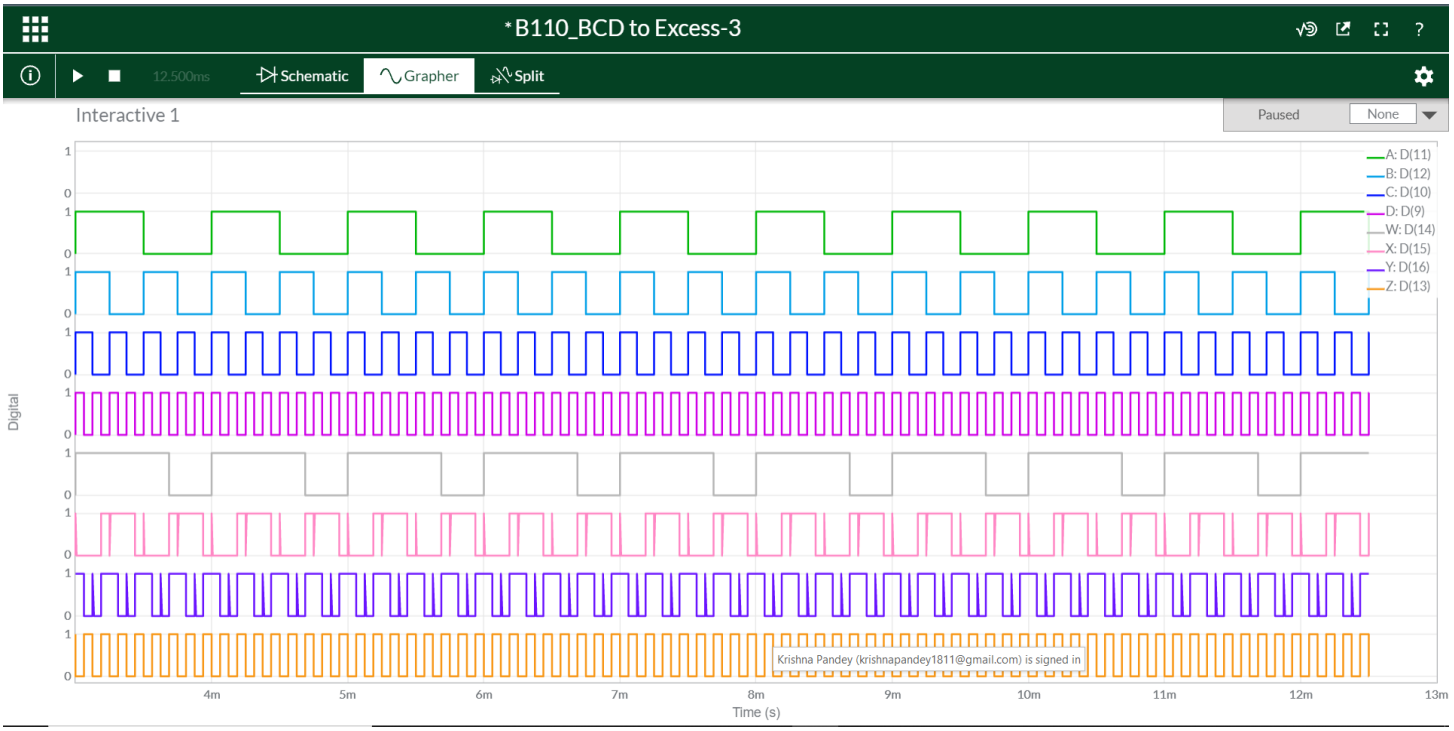
CIRCUIT/CONNECTION DIAGRAMS (FROM MULTISIM)

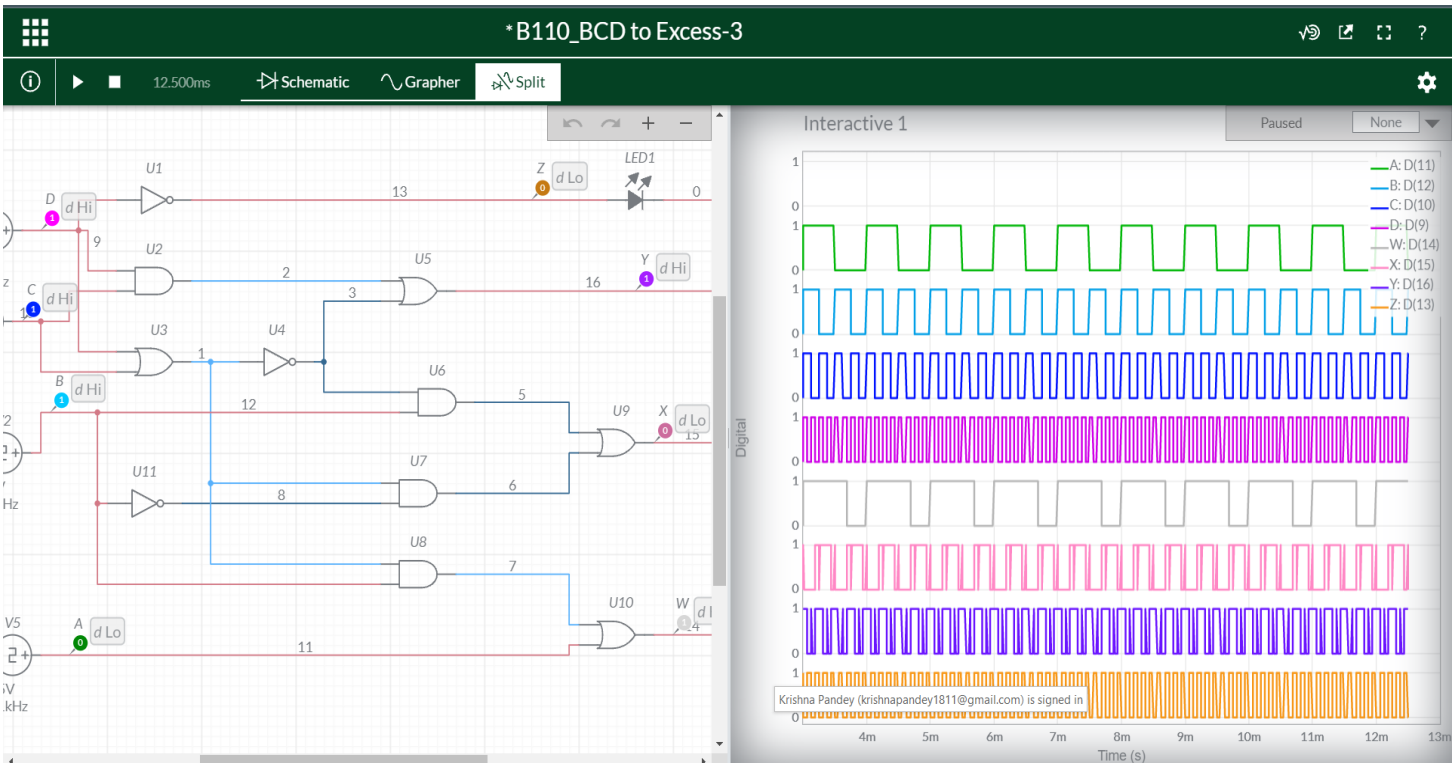
ALONG WAVEFORMS (FROM MULTISIM)

BCD TO EXCESS-3 CIRCUIT: -



BCD TO EXCESS-3 OUTPUT: -



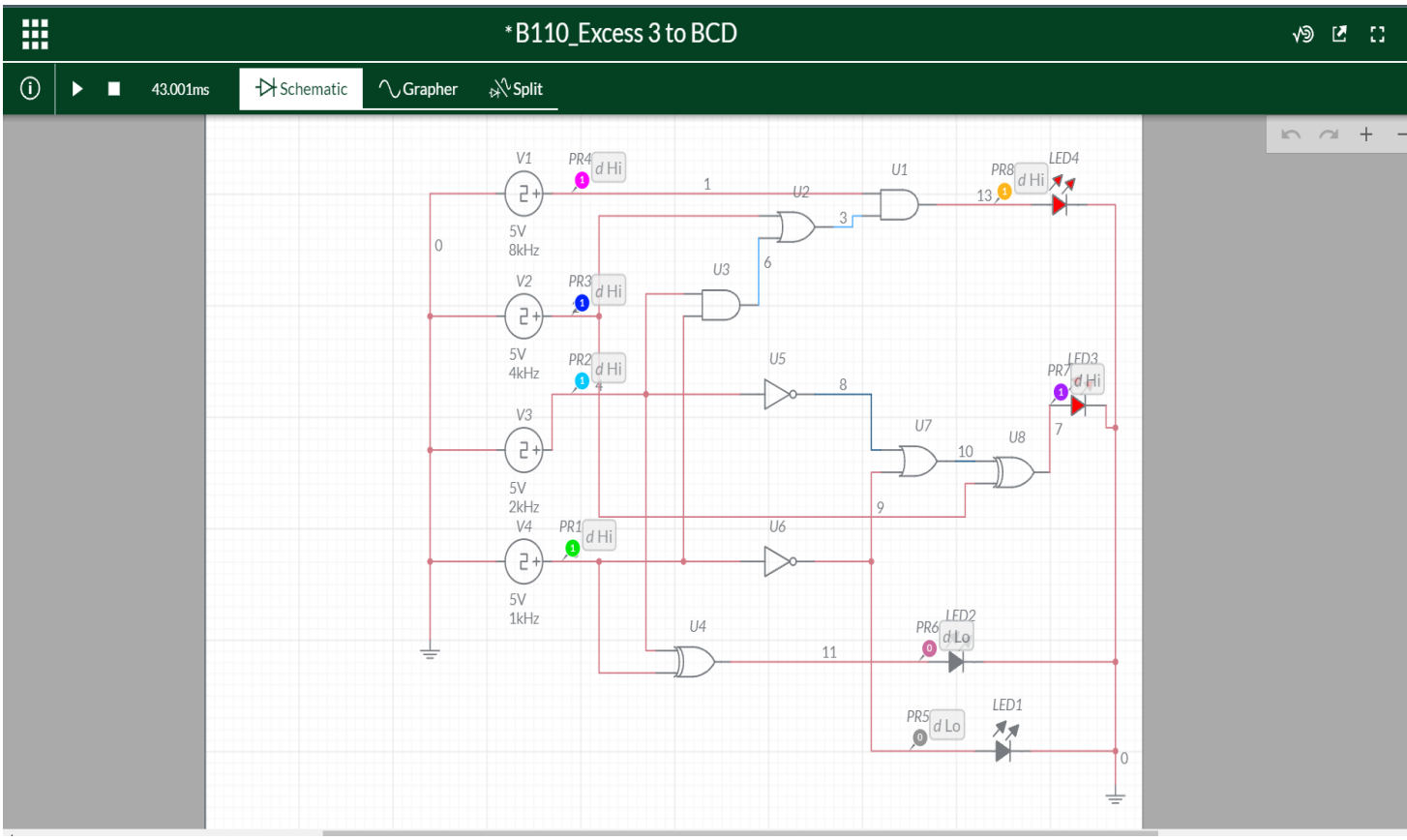


CIRCUIT/CONNECTION DIAGRAMS (FROM MULTISIM)

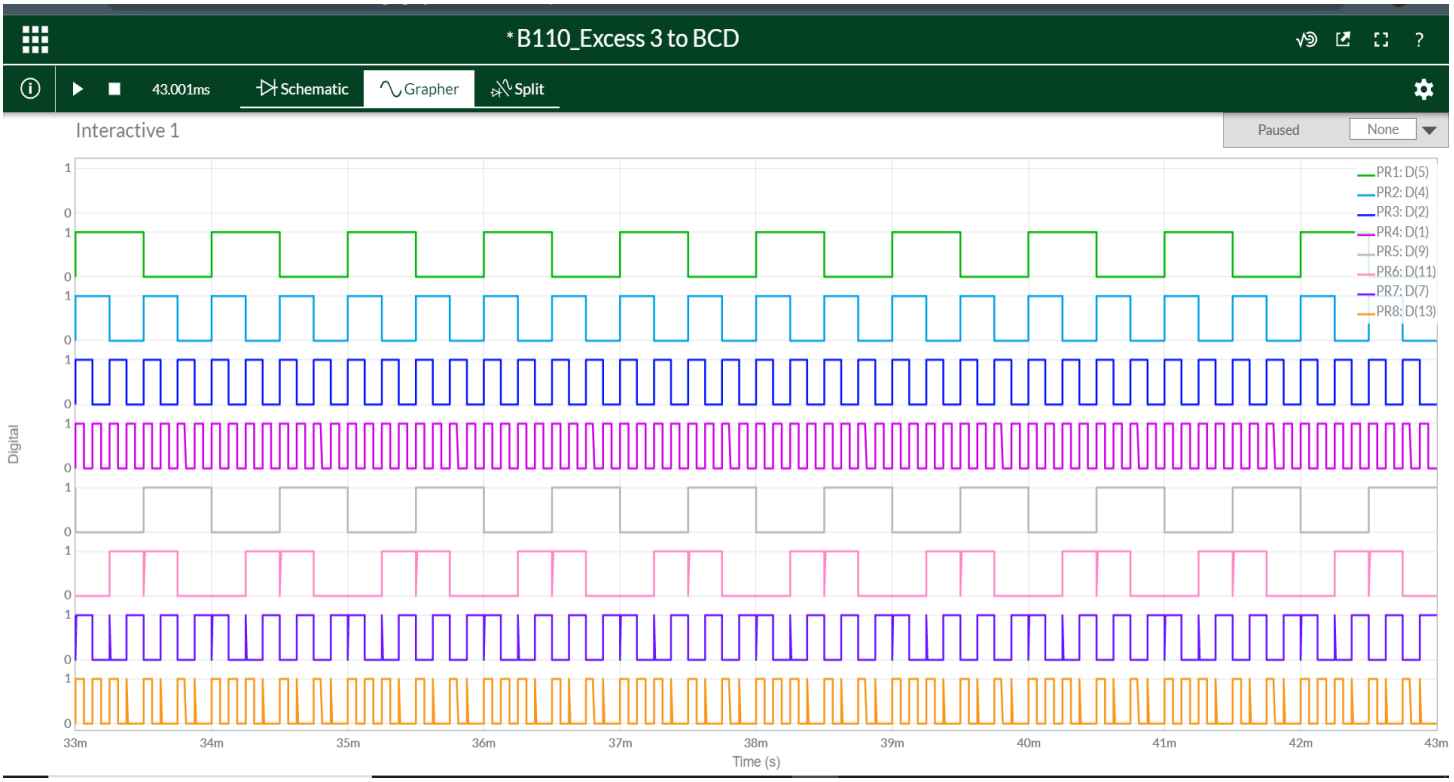
ALONG WAVEFORMS (FROM MULTISIM)

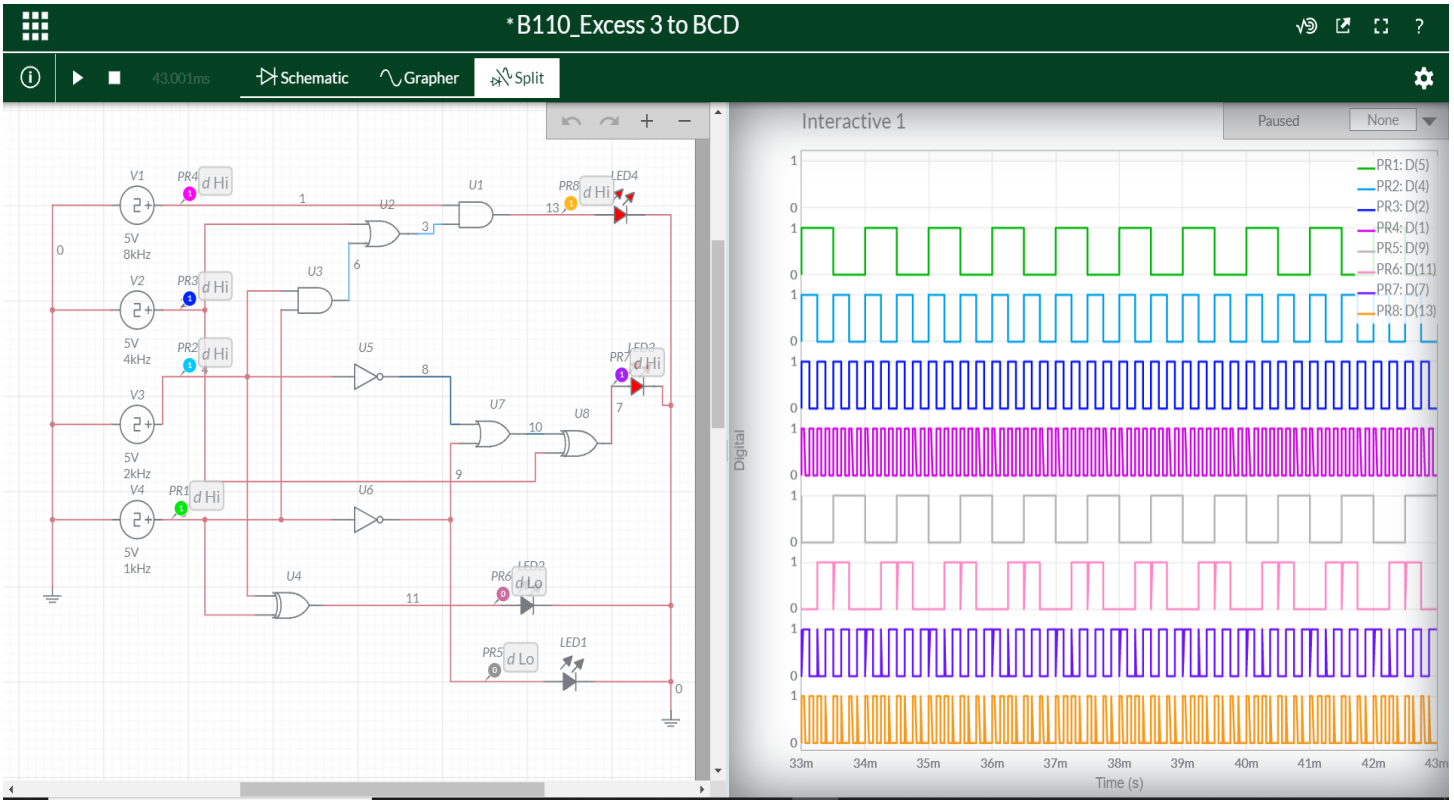
ASSIGNMENT

EXCESS-3 TO BCD CIRCUIT: -



EXCESS-3 TO BCD OUTPUT: -





• CONCLUSIONS :-

THE TRUTH TABLE IN THEORY AND THE SIMULATION OF THE BCD TO EXCESS-3 CODE CONVERTOR CIRCUIT AND VICE-VERSA CIRCUIT ON MULTISIM LIVE BOTH ARE EQUAL. HENCE VERIFIED.