___________*EXPERIMENT NUMBER 5*

- **OBJECTIVE:**

To Design and Simulate BCD to Excess 3, Excess 3 to BCD code converters.

- ***APPARTUS REQUIRED:***

➢ Power supply
➢ LED
➢ Resistance
➢ Switches

- **THEORY:**

- BCD Codes:

Numeric codes represent numeric information i.e. only numbers as a series of 0’s and 1’s. Numeric codes used to represent decimal digits are called Binary Coded Decimal (BCD) codes. A BCD code is one, in which the digits of a decimal number are encoded-one at a time into group of four binary digits. There are a large number of BCD codes in order to represent decimal digits0, 1, 2,……9, it is necessary to use a sequence of at least four binary digits. Such a sequence of binary digits which represents a decimal digit is called code word.

- ## EXCESS-3 CODE:

It is a non-weighted code. It is also a self-complementing BCD code used in decimal arithmetic units. . The Excess-3 code for the decimal number is performed in the same manner as BCD except that decimal number 3 is added to the each decimal unit before encoding it to binary.

- ## BCD to Excess-3:

To convert from binary code A to binary code B, the input lines must supply the bit combination of elements as specified by code A and the output lines must generate the corresponding bit combination of code B. A combinational circuit performs this transformation by means of logic gates. As we want to design 4-bit code, we must use four input variables and four output variables. Designate the four input binary variables by the symbols A,B,C,D, and the four output variables by w, x, y, and z. The truth table relating the input and output variables is as shown. A two-level logic diagram may be obtained directly from the Boolean expressions derived by the maps. The expressions obtained may be manipulated for the purpose of using common gates for two or more outputs. This manipulation illustrates flexibility obtained with multiple-output systems when implemented with three or more levels of gates.

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

Table: BCD to Excess-3 Converter

Decimal	BCD					Excess-3			
Digit	A	B	C	D		w	x	y	Z
0	0	0	0	0		0	0	1	1
1	0	0	0	1		0	1	0	0
2	0	0	1	0		0	1	0	1
3	0	0	1	1		0	1	1	0
4	0	1	0	0		0	1	1	1
5	0	1	0	1		1	0	0	0
6	0	1	1	0		1	0	0	1
7	0	1	1	1		1	0	1	0
8	1	0	0	0		1	0	1	1
9	1	0	0	1		1	1	0	0

- ## Excess-3 TO BCD :

We know that, excess-3 code begins with the binary 0011(decimal 3) and it will continue up to binary 1100(decimal 12) where I get the output binary 1001(decimal 9) for input binary 1100(decimal 12). So I need 4 variables as inputs and 4 variables as outputs. With 4 variables I can represent 16 binary values from 0000 to 1111. Since I do not use 0, 1, 2, 13, 14, 15 as inputs, when I simplify the output function I use those terms as don't care conditions.

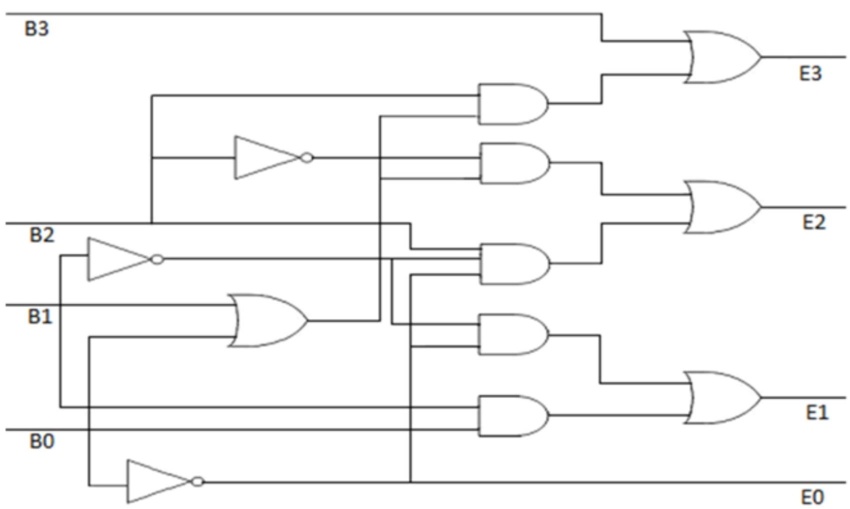
A=WX+WYZ
B=X'Y' + XYZ +Z'
C=YZ'+Y'Z
D=Z'

Table: Excess-3 to BCD Converter

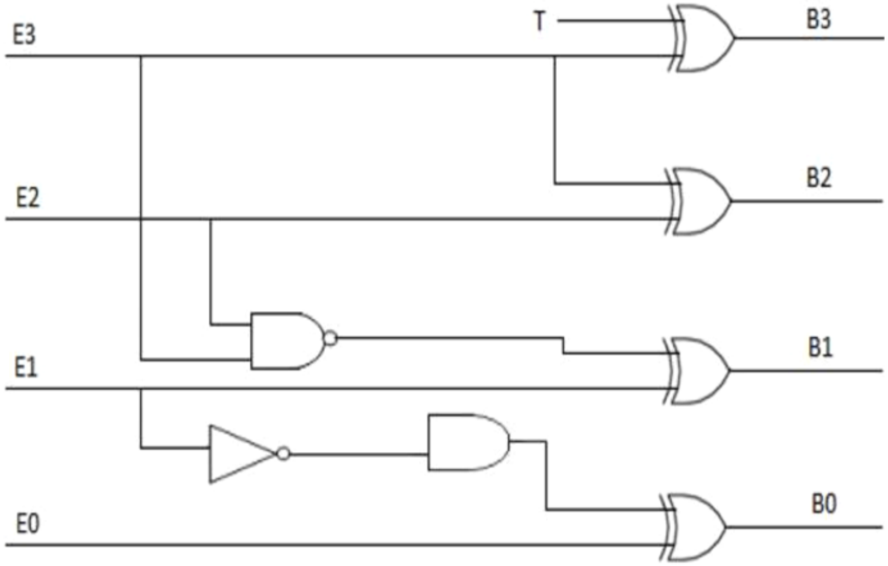
Inputs				Outputs			
W	X	Y	Z	A	B	C	D
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	1
0	1	0	1	0	0	1	0
0	1	1	0	0	0	1	1
0	1	1	1	0	1	0	0
1	0	0	0	0	1	0	1
1	0	0	1	0	1	1	0
1	0	1	0	0	1	1	1
1	0	1	1	1	0	0	0
1	1	0	0	1	0	0	1

- **CIRCUIT DIAGRAM:**

- Logic Diagram for BCD to Excess-3 Code Converter:

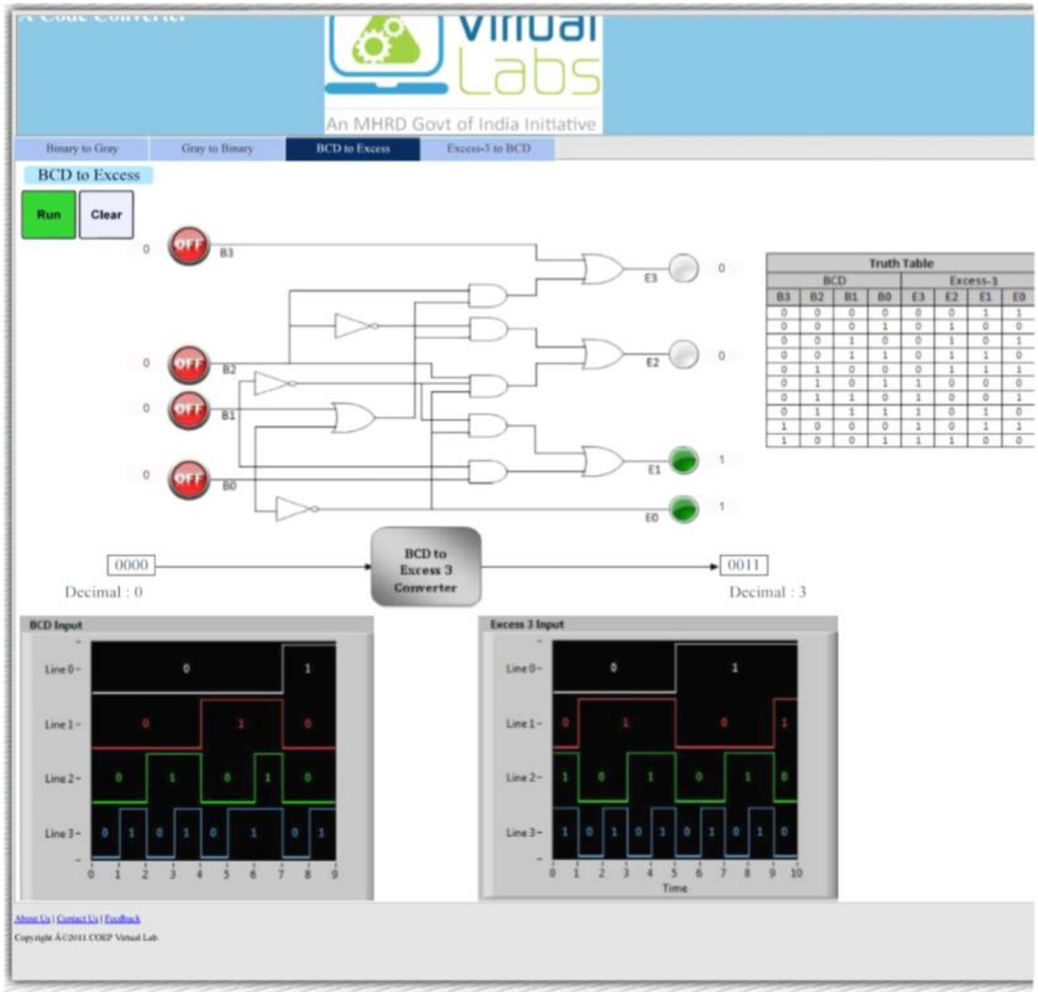


- Logic Diagram for Excess-3 Code to BCD Converter:

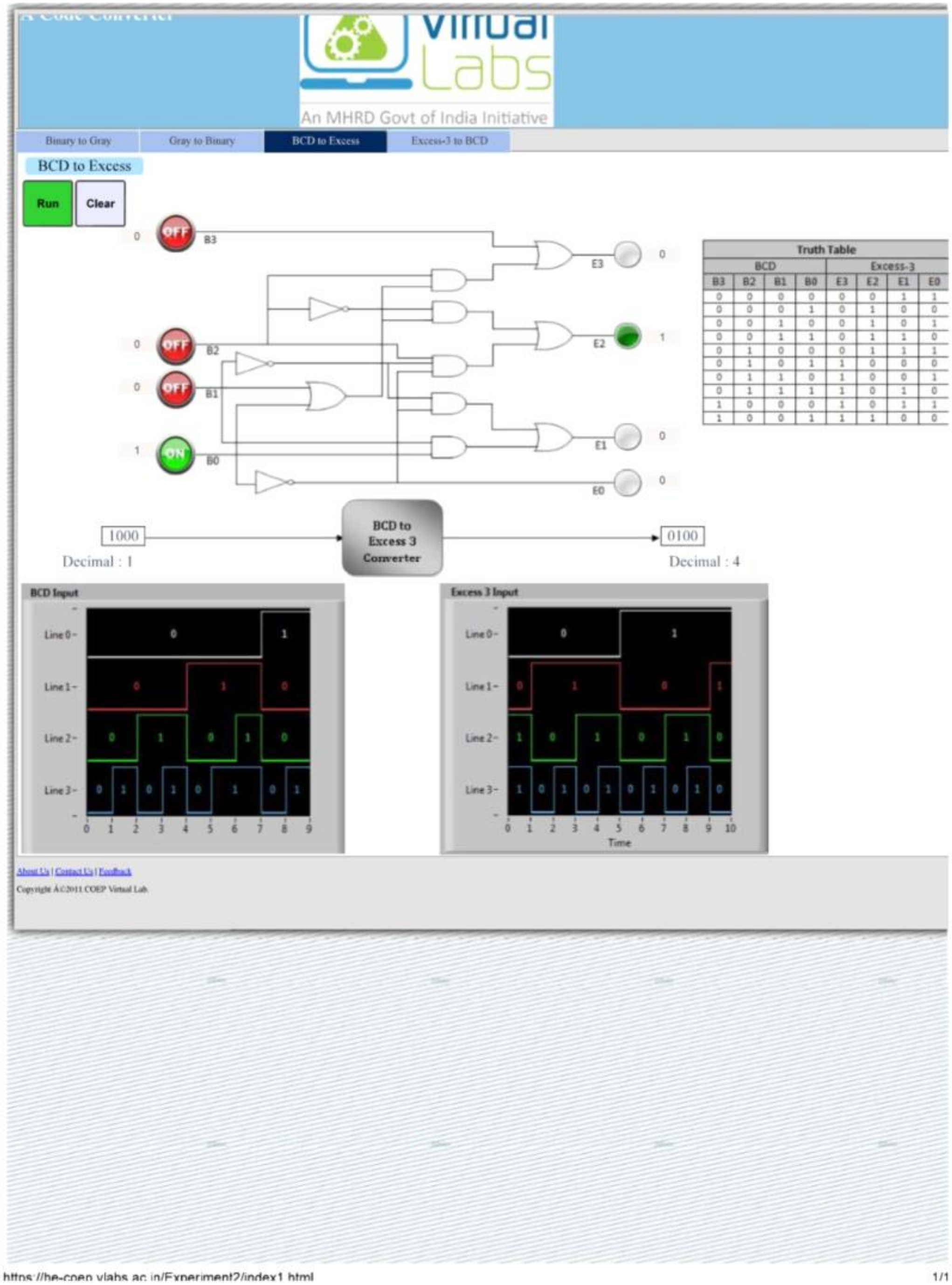


- **CALCULATIONS:**

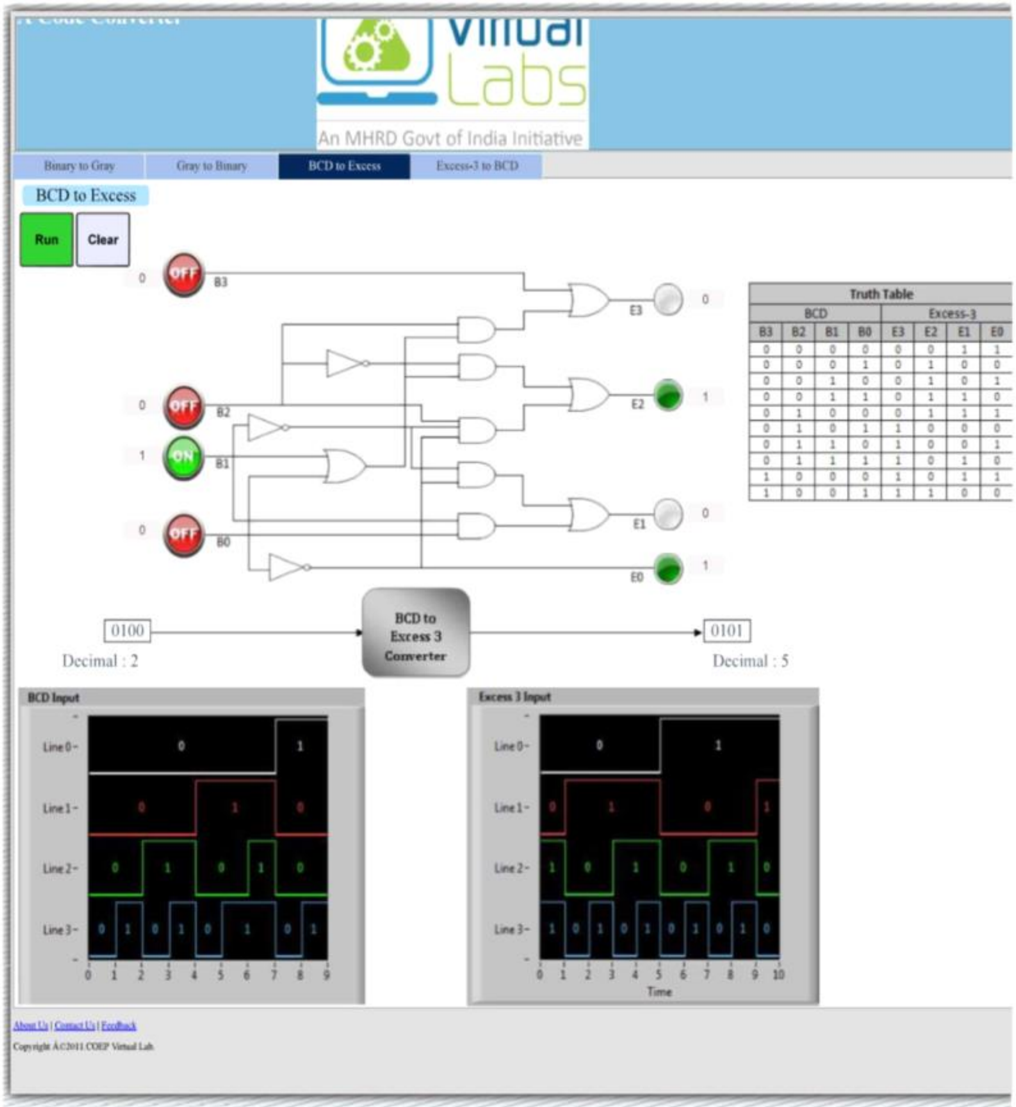
➢ **Verification for BCD to Excess-3 Code Converter:**



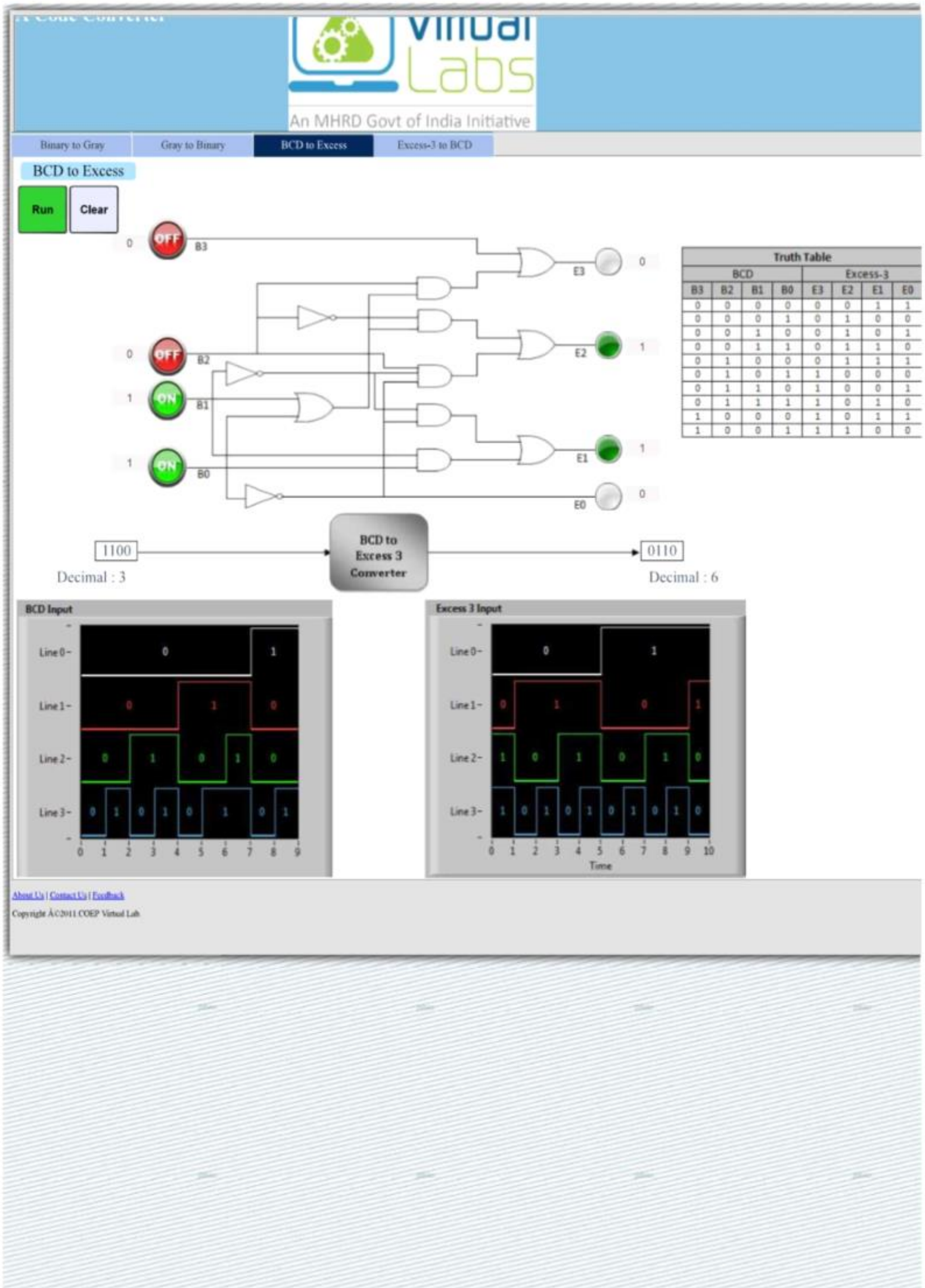
Truth Table							
BCD				Excess-3			
B3	B2	B1	B0	E3	E2	E1	E0
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0



Truth Table							
BCD				Excess-3			
B3	B2	B1	B0	E3	E2	E1	E0
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



Truth Table							
BCD				Excess-3			
B3	B2	B1	B0	E3	E2	E1	E0
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



Truth Table							
BCD				Excess-3			
B3	B2	B1	B0	E3	E2	E1	E0
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

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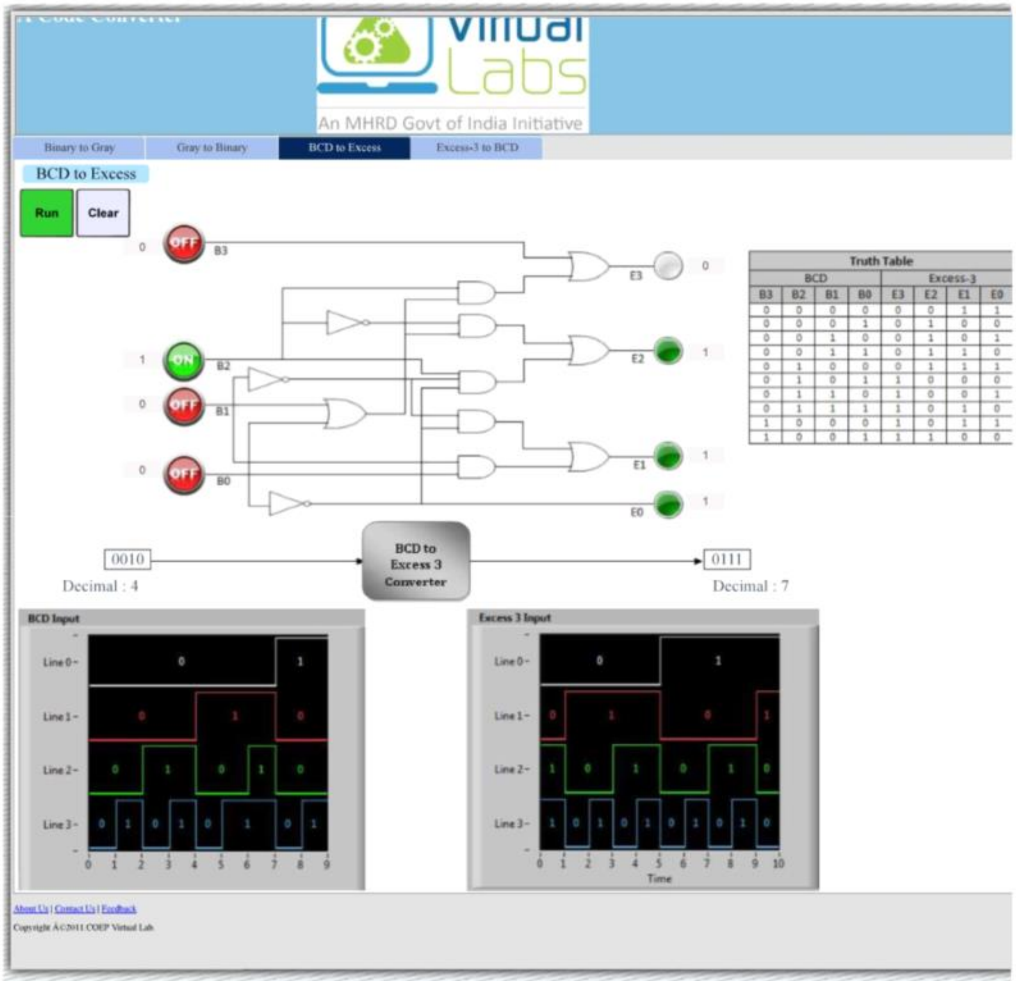

Truth Table							
BCD				Excess-3			
B3	B2	B1	B0	E3	E2	E1	E0
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0

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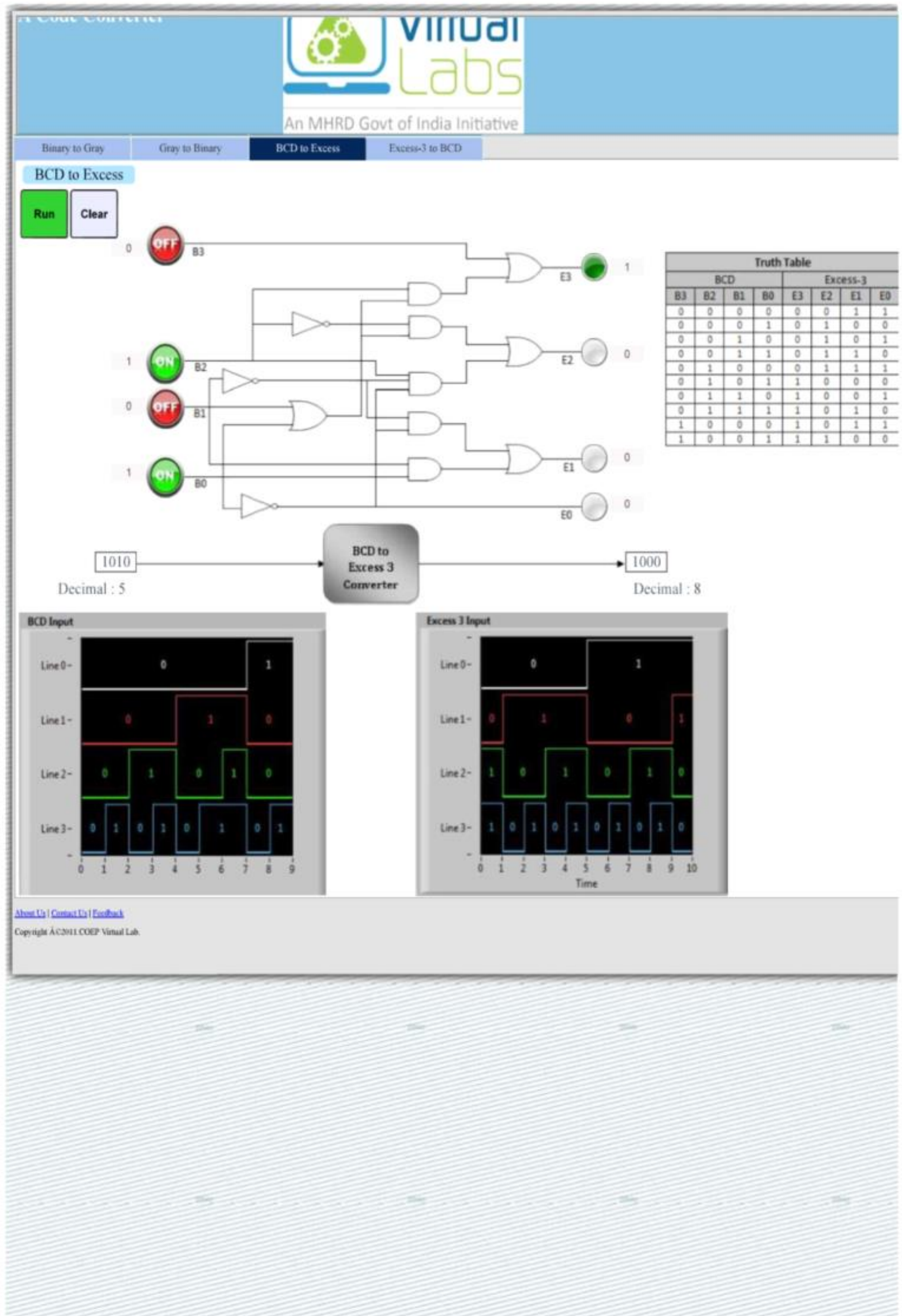

Truth Table							
BCD				Excess-3			
B3	B2	B1	B0	E3	E2	E1	E0
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0

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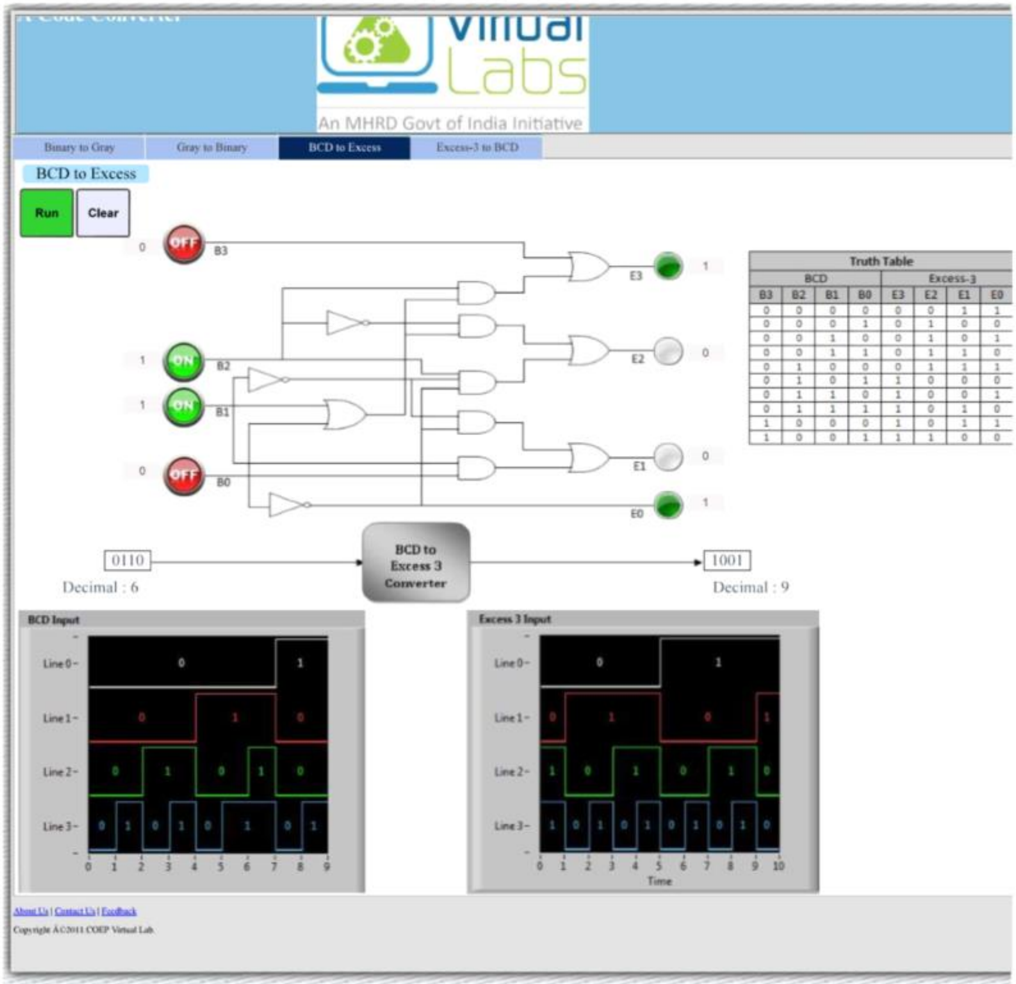
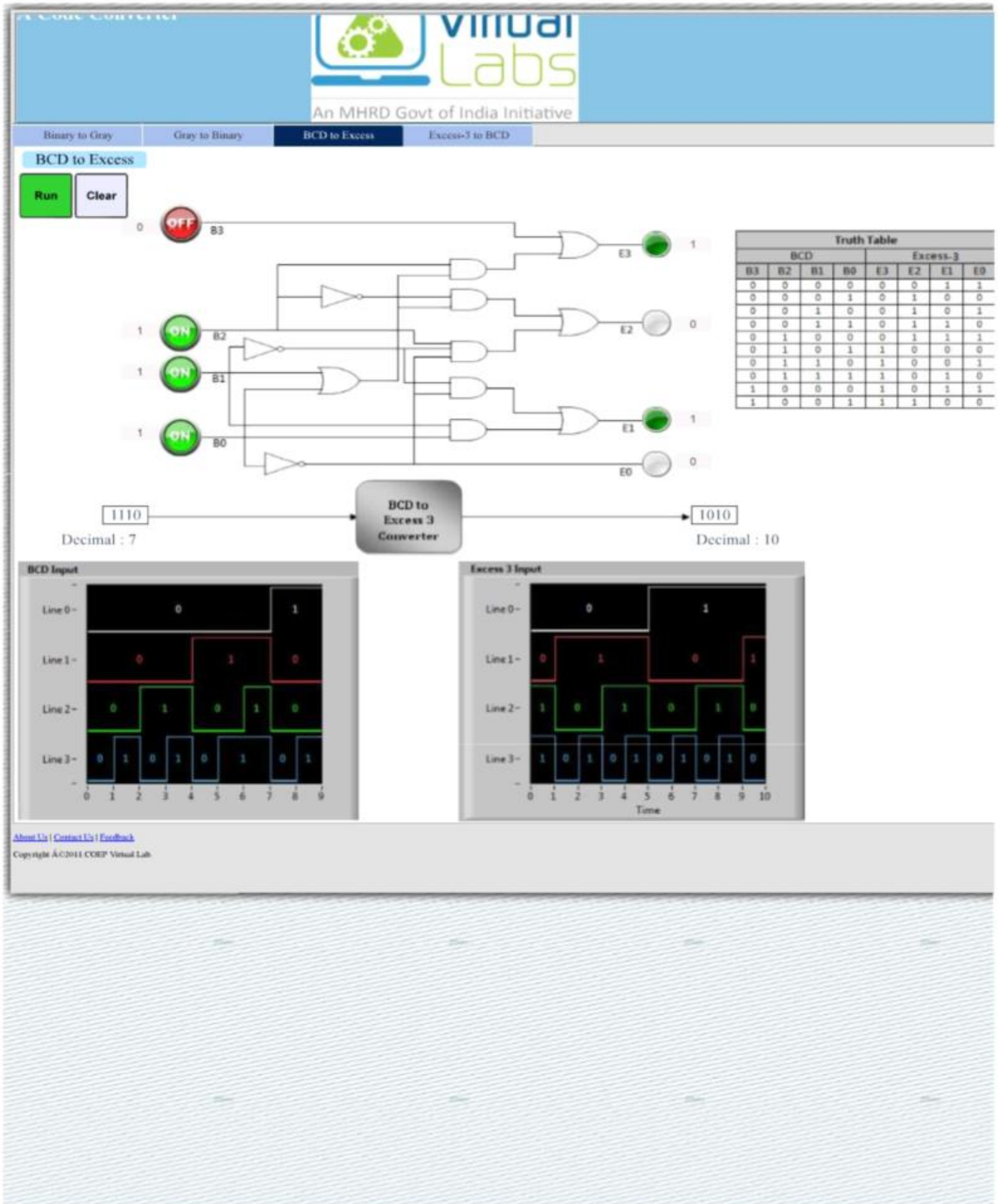


Truth Table							
BCD				Excess-3			
B3	B2	B1	B0	E3	E2	E1	E0
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0



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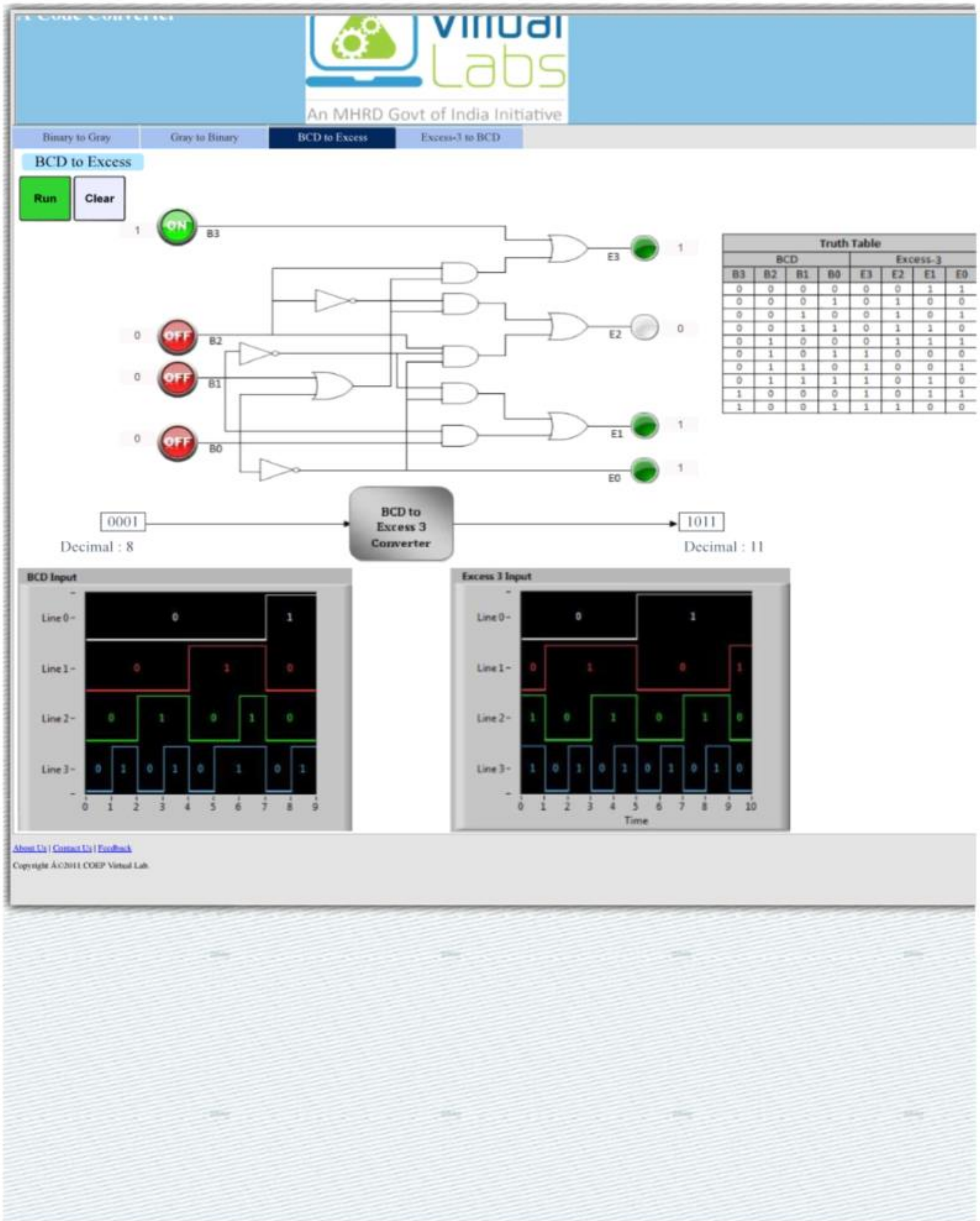

Truth Table							
BCD				Excess-3			
B3	B2	B1	B0	E3	E2	E1	E0
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0

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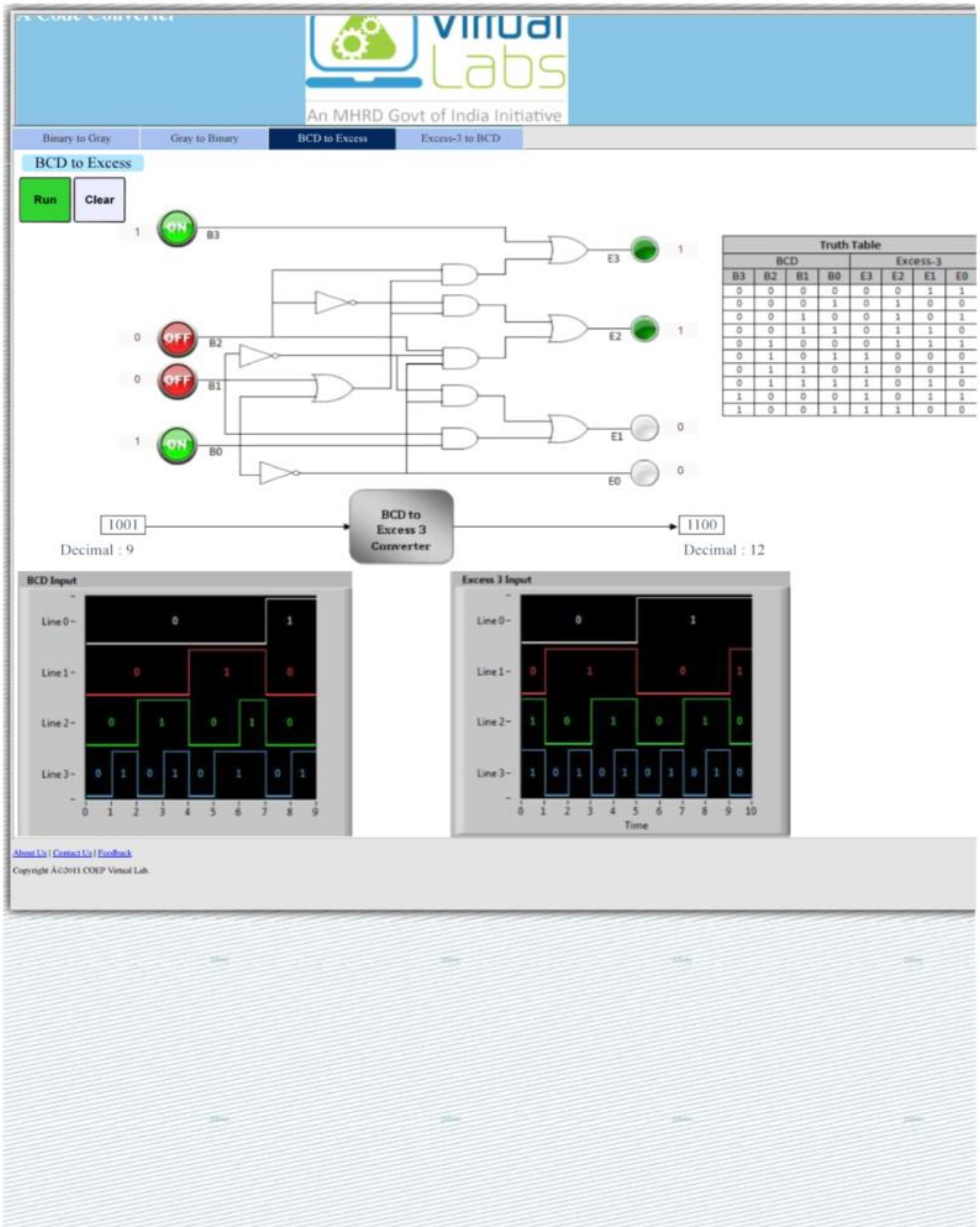

Truth Table							
BCD				Excess-3			
B3	B2	B1	B0	E3	E2	E1	E0
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0

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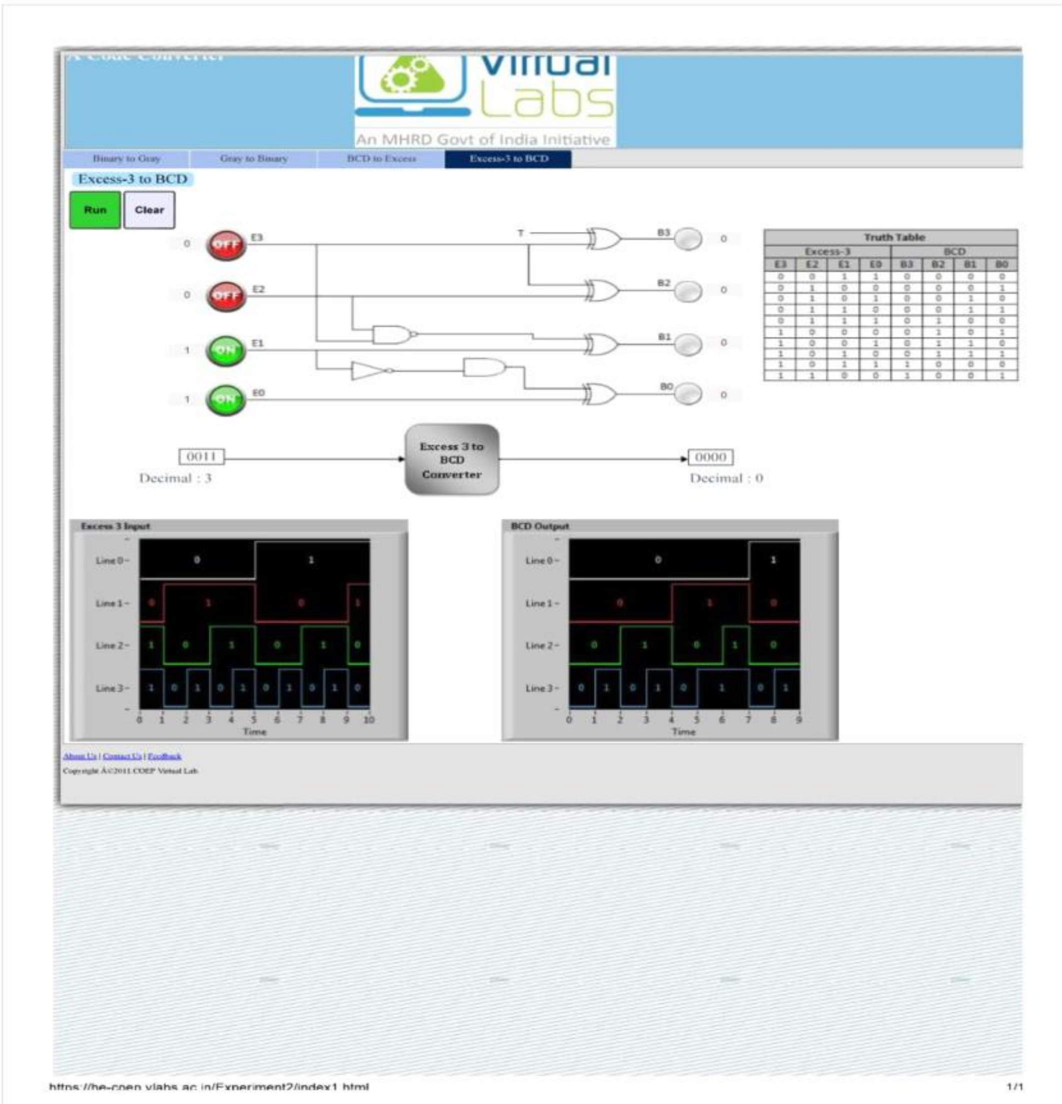
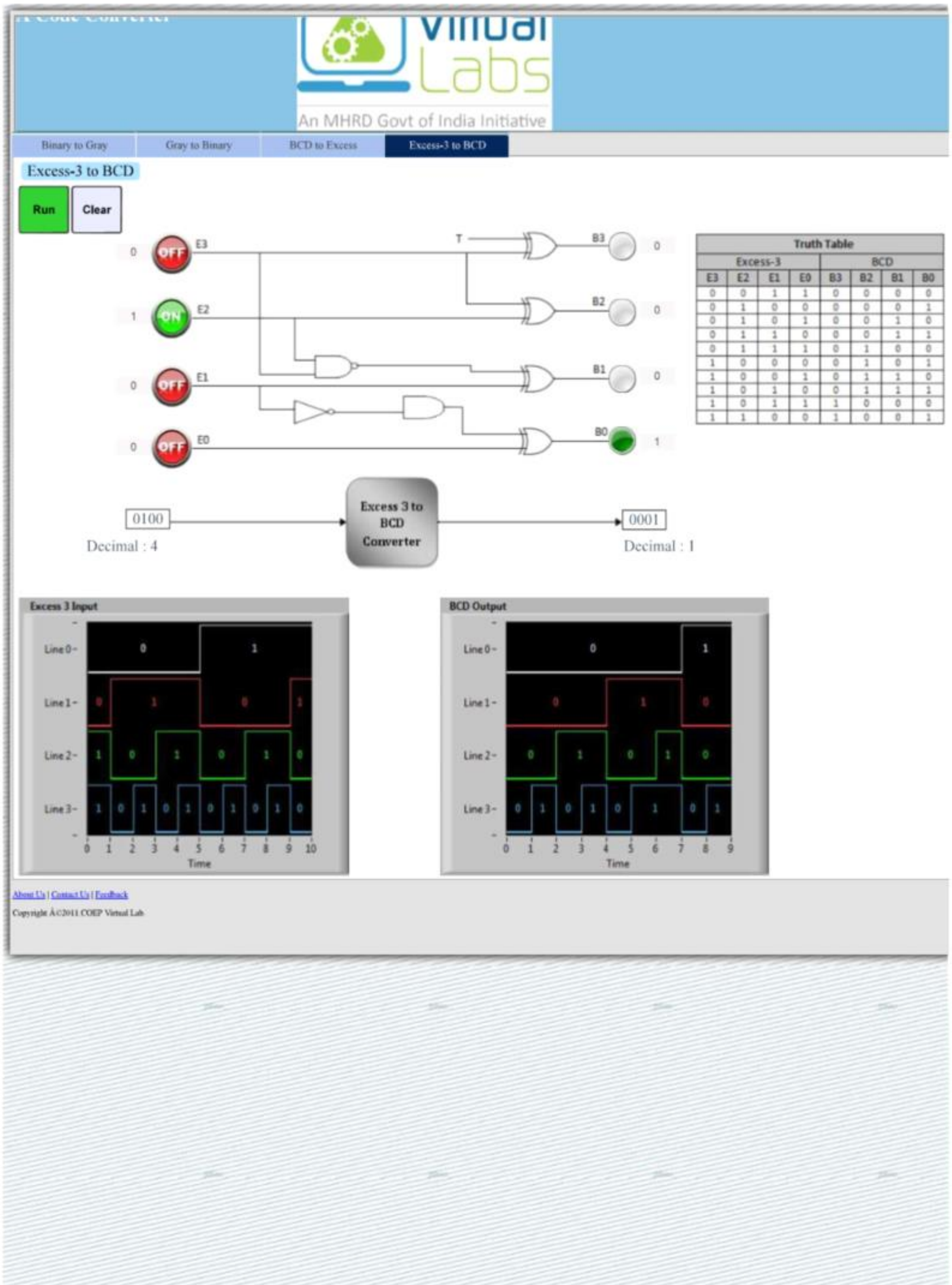
➢ Verification for Excess-3 to BCD Code Converter:





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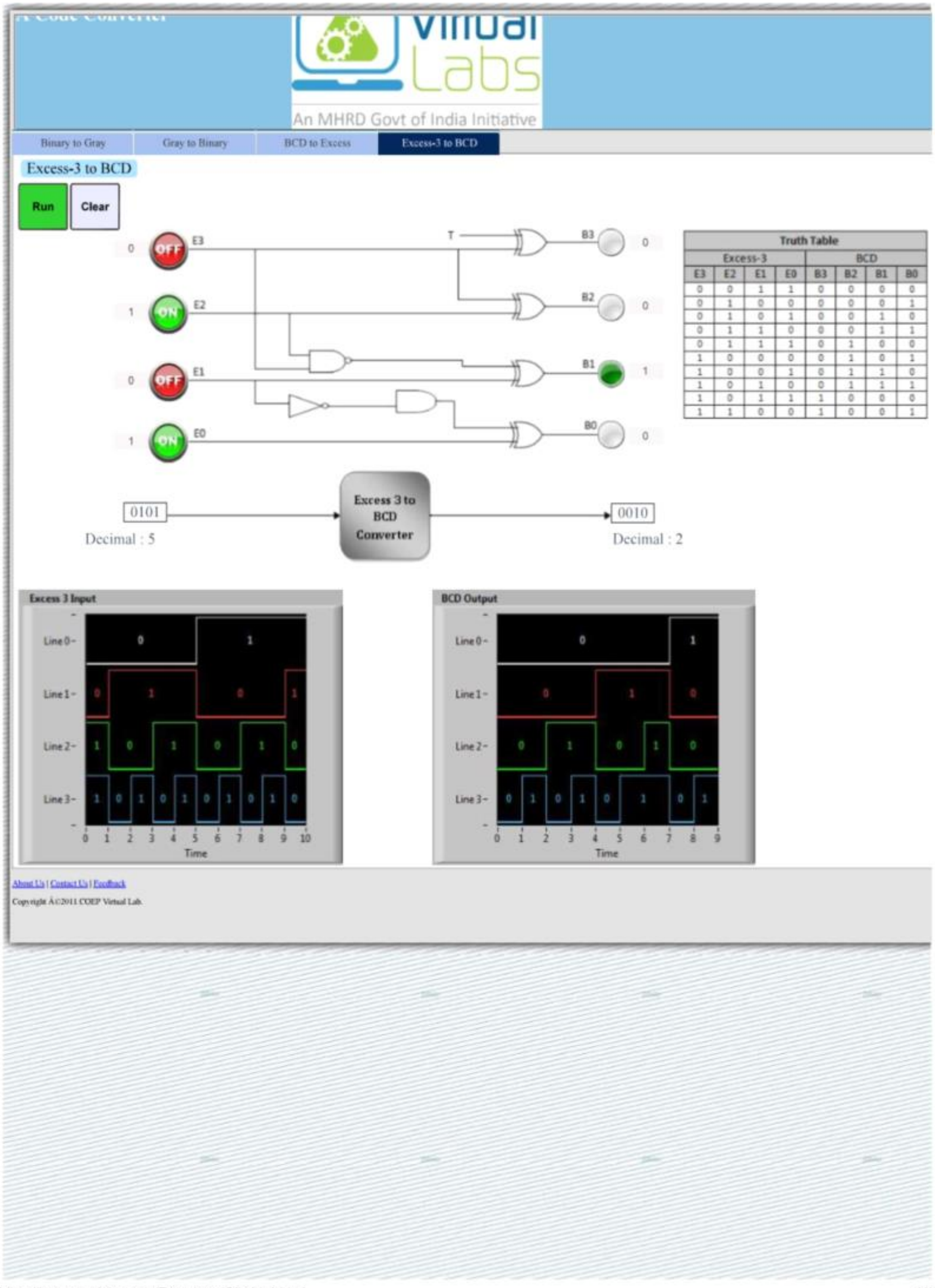

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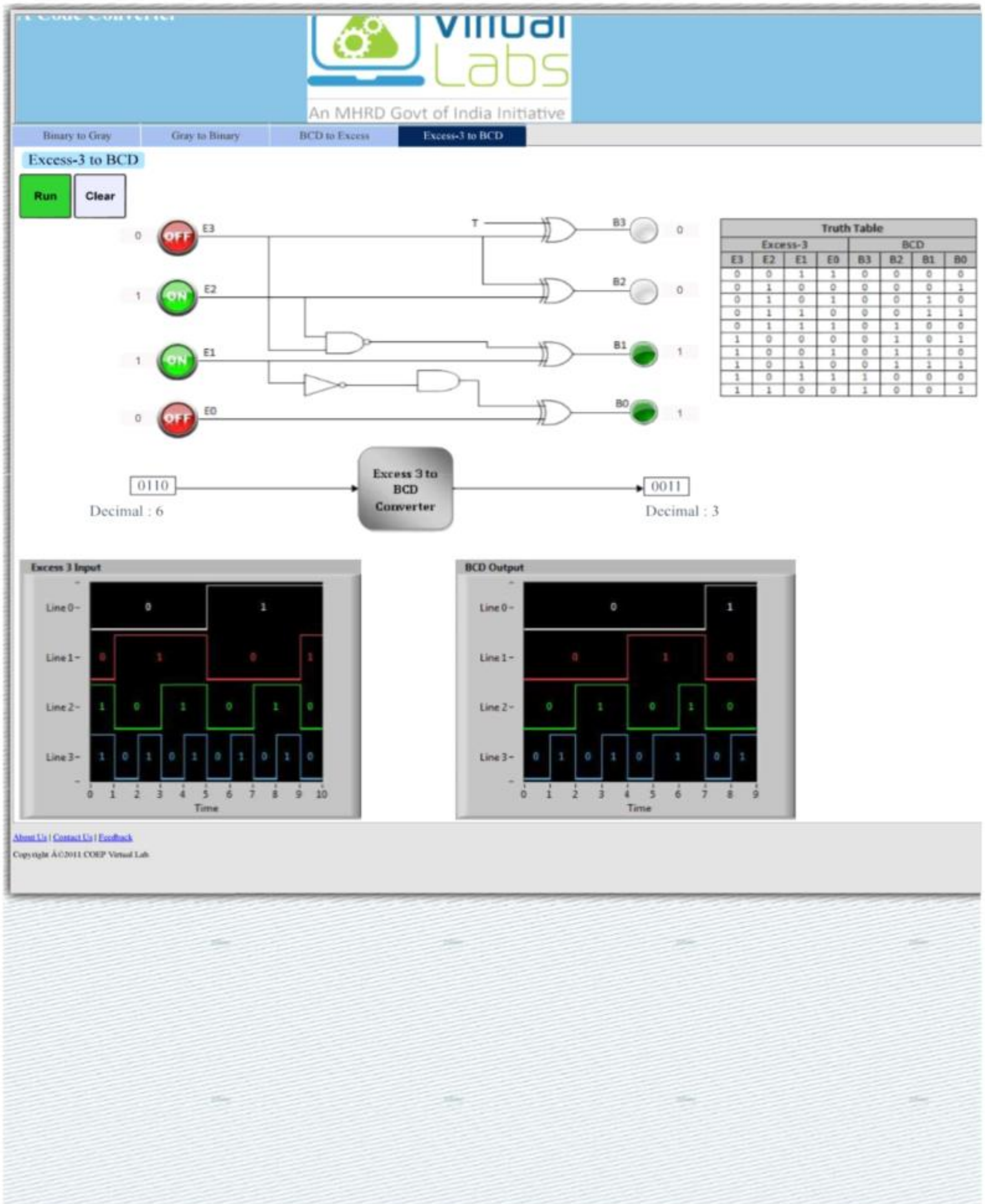

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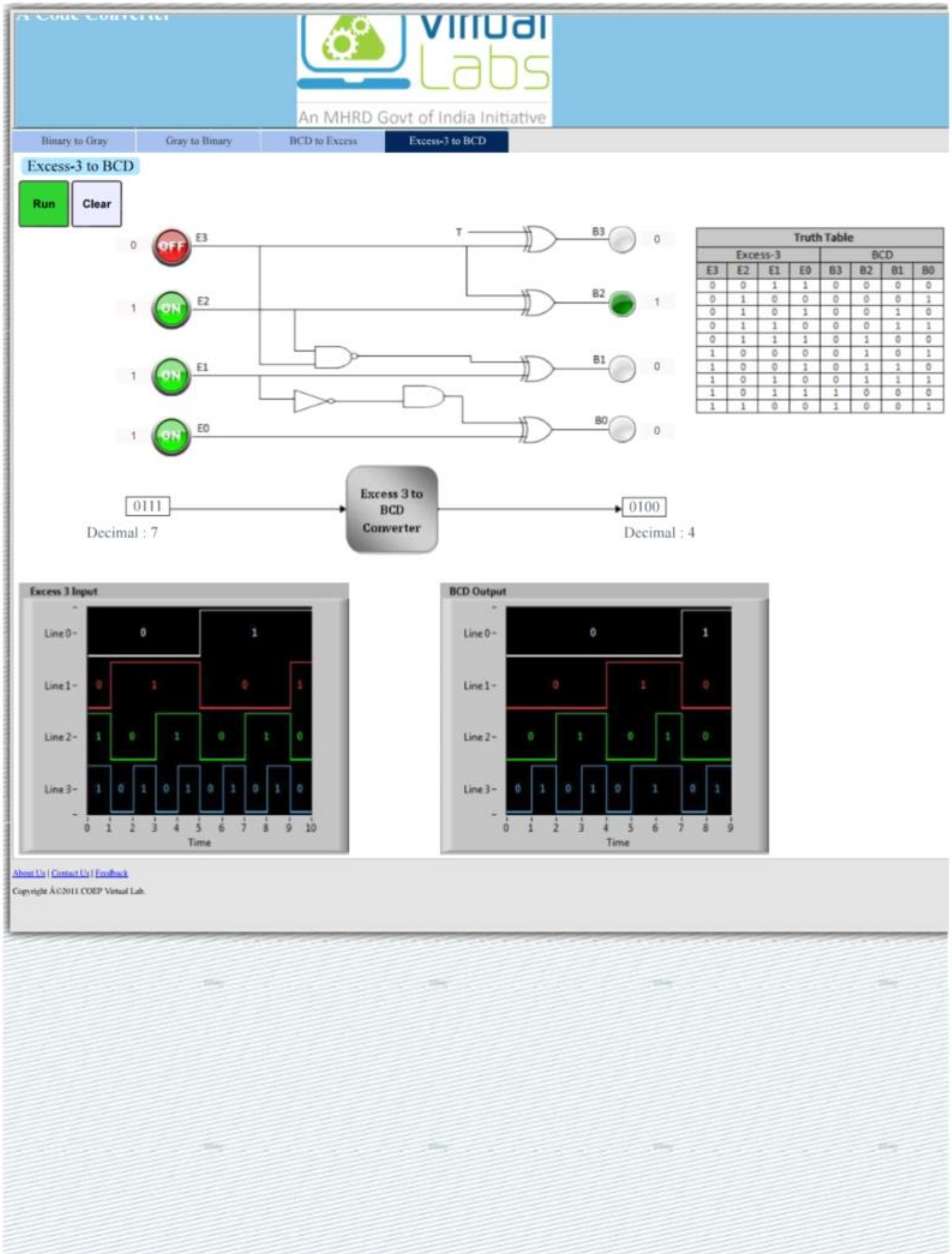

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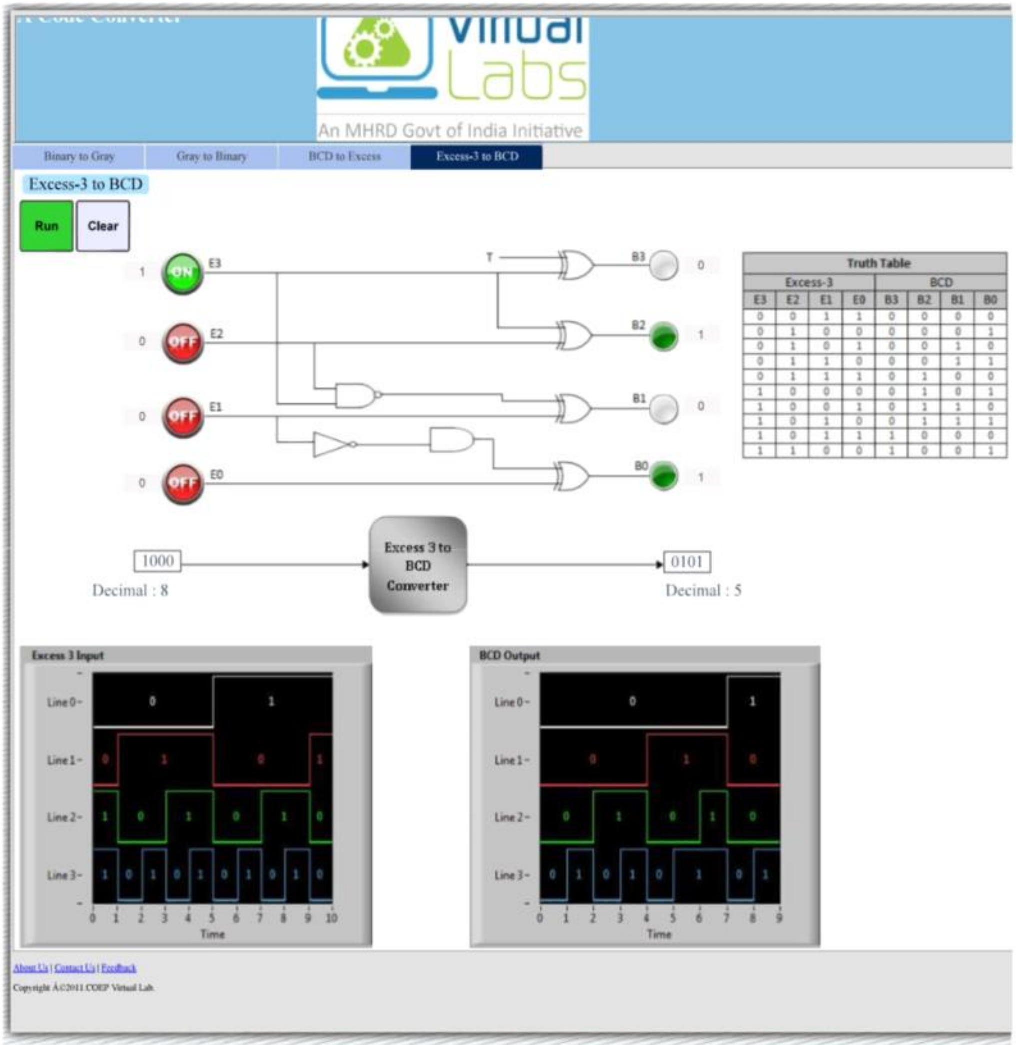

Excess-3				BCD			
E3	E2	E1	E0	B3	B2	B1	B0
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	1
0	1	0	1	0	0	1	0
0	1	1	0	0	0	1	1
0	1	1	1	0	1	0	0
1	0	0	0	0	1	0	1
1	0	0	1	0	1	1	0
1	0	1	0	0	1	1	1
1	0	1	1	1	0	0	0
1	1	0	0	1	0	0	1

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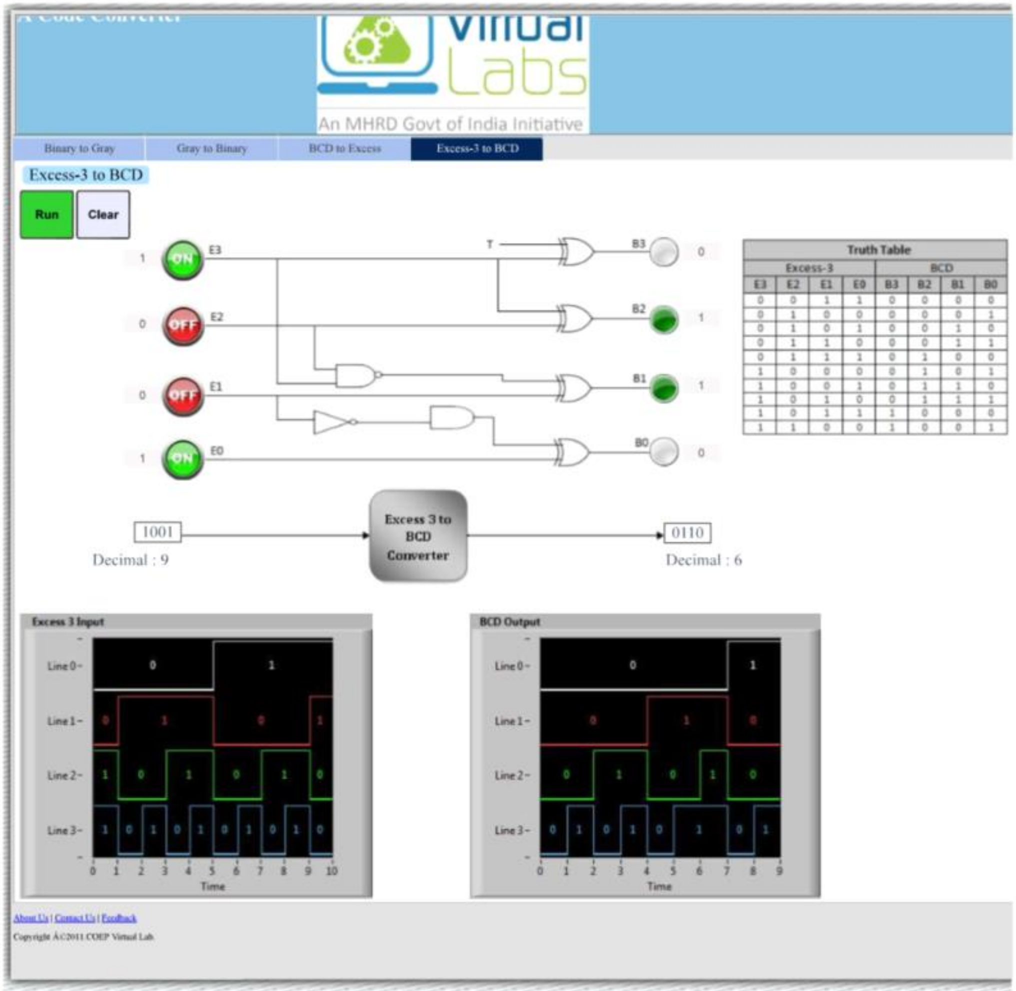

Truth Table							
Excess-3				BCD			
E3	E2	E1	E0	B3	B2	B1	B0
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	1
0	1	0	1	0	0	1	0
0	1	1	0	0	0	1	1
0	1	1	1	0	1	0	0
1	0	0	0	0	1	0	1
1	0	0	1	0	1	1	0
1	0	1	0	0	1	1	1
1	0	1	1	1	0	0	0
1	1	0	0	1	0	0	1

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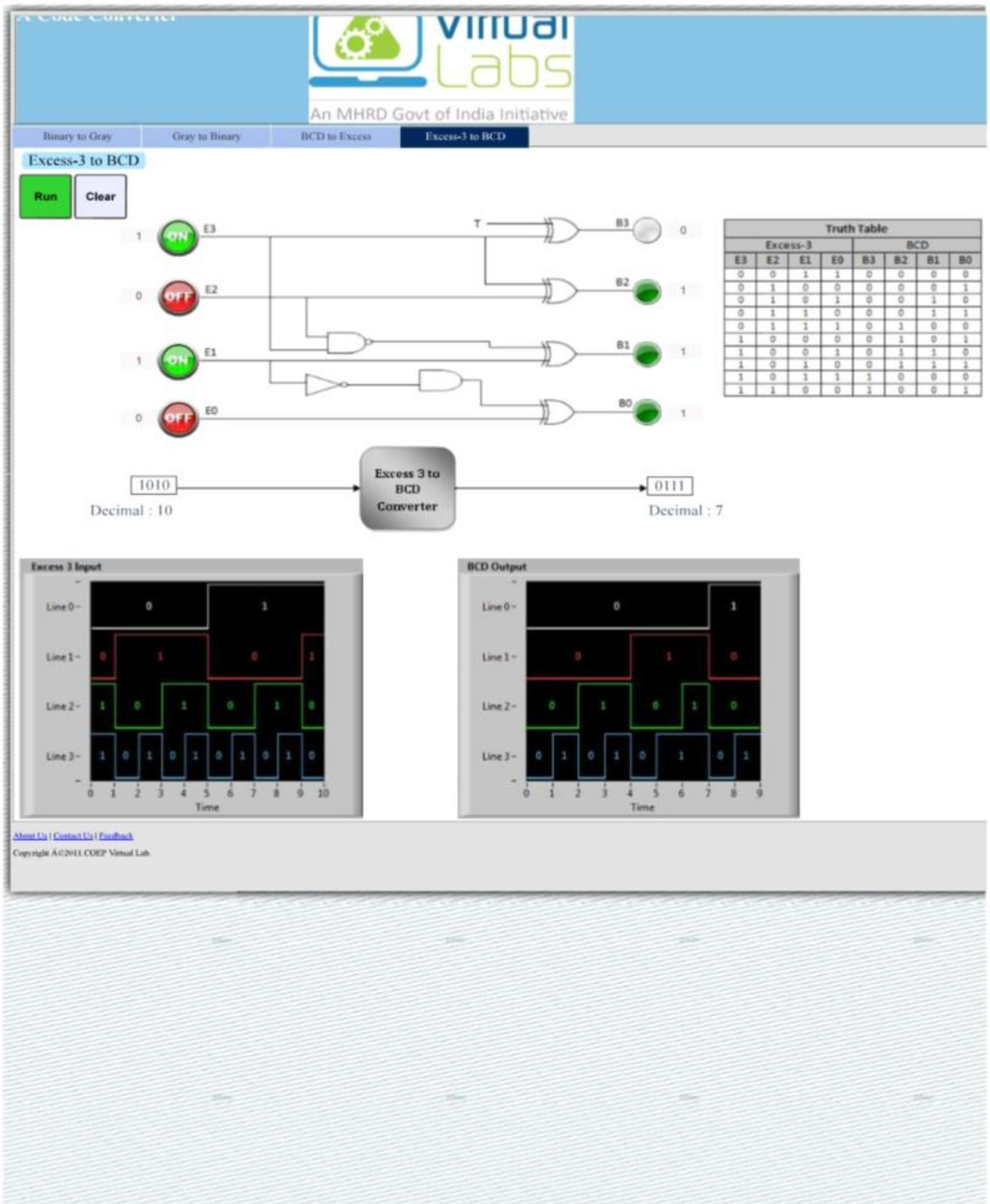

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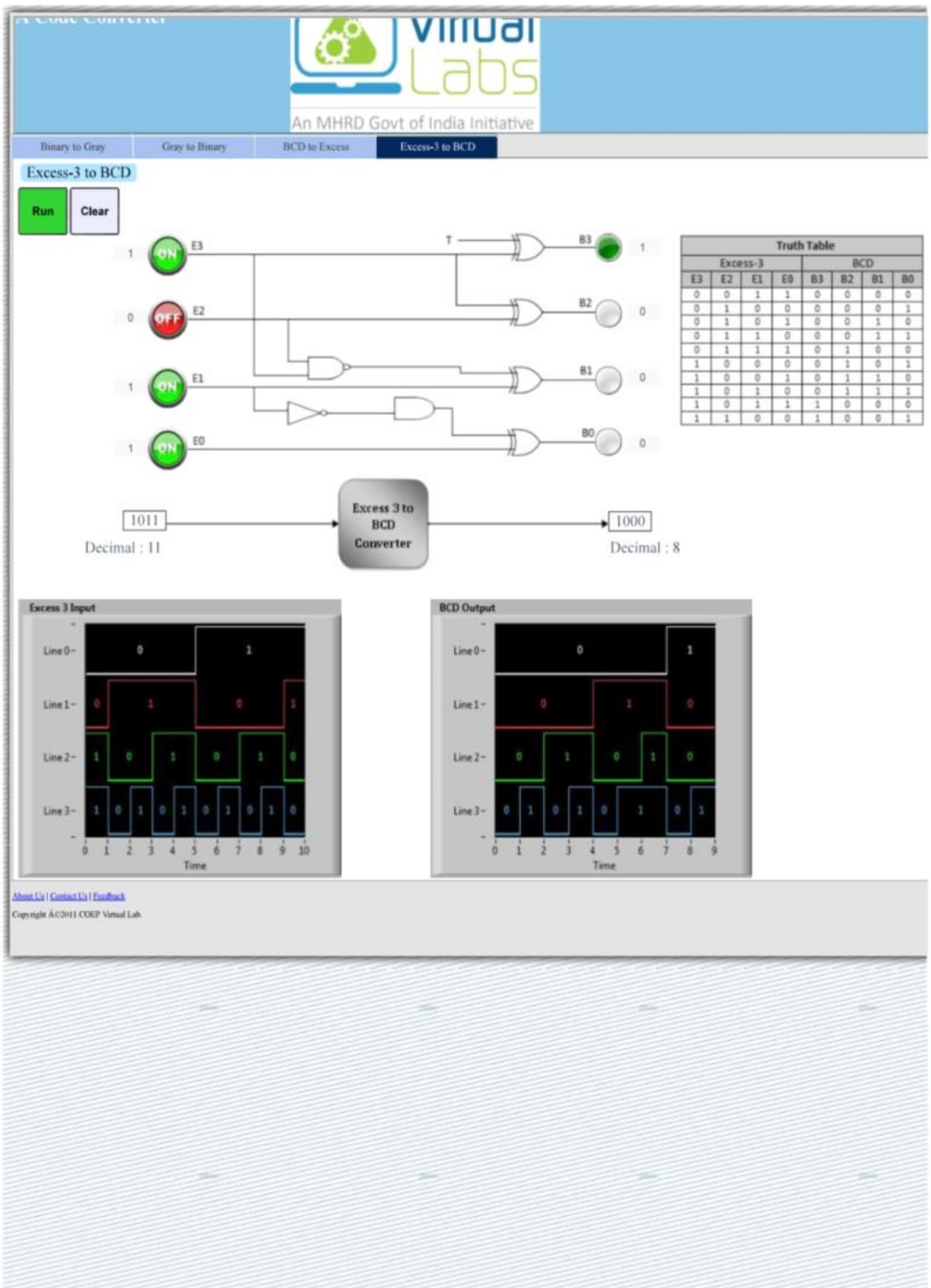

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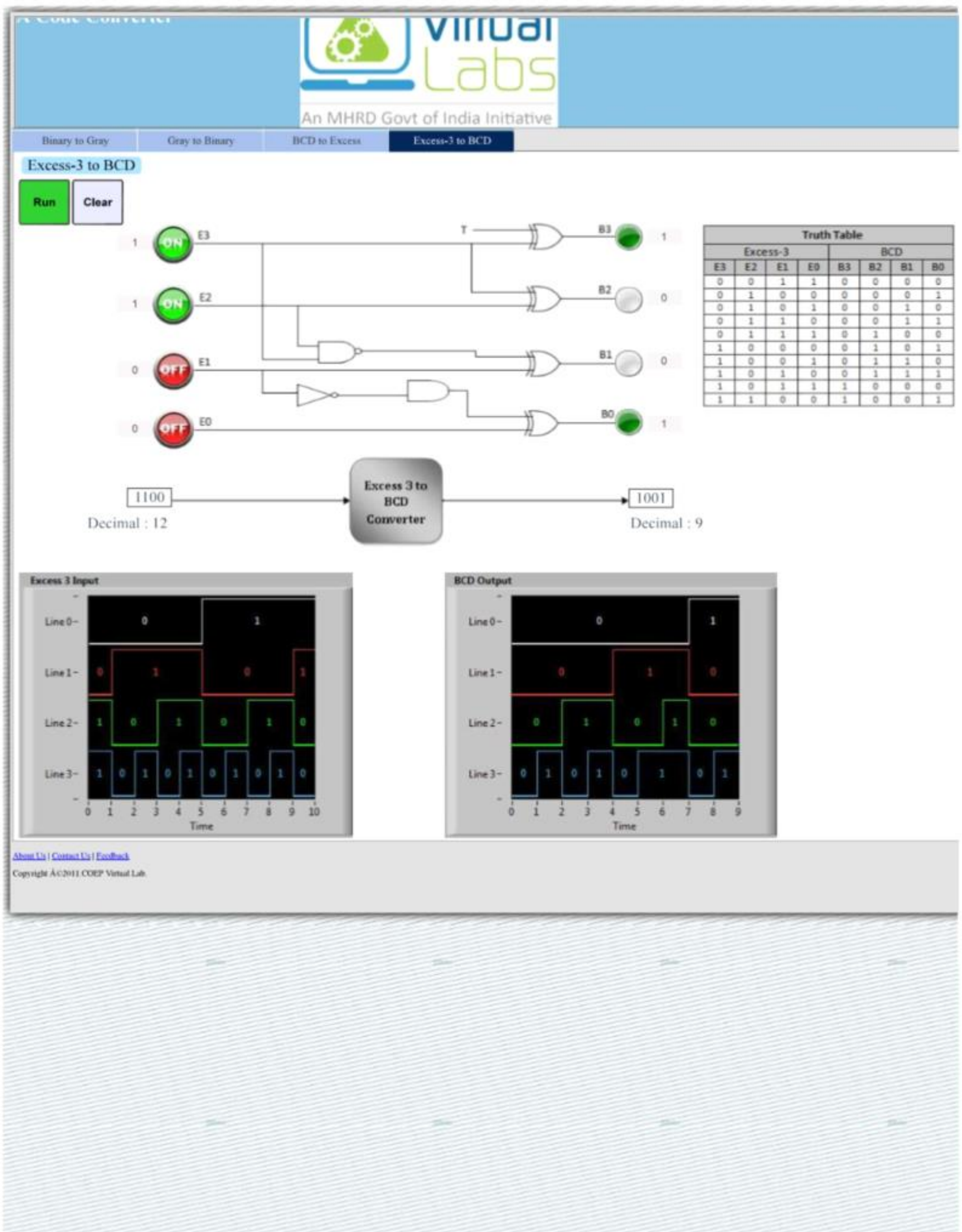

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- ## RESULT AND CONCLUSION:

  - Verified the Truth Table of Conversion of BCD to Excess 3 code.
  - Verified the Truth Table of Conversion of Excess 3 to BCD code.

- ## *PRECAUTIONS:*

  - All the connections should be made properly as per the circuit diagram.
  - Connections should be tight and easy to inspect.
  - Power supply should be 5v.
  - Keep the switch turned off while making connections.