Lab Assignment – 6
EXPERIMENTS ON DECODER

OBJECTIVE:

- Verify the truth table of 74139 IC (Dual 2-line to 4-line decoder).
- Show that with an extra gate 74139 IC works as a universal logic block.
- Realize a 3x8 decoder using two sections of a 74139 IC and hence implement the following function using the 3x8 decoder and some extra gates if necessary:

$$F = A.\overline{B}.\overline{C} + \overline{A}.B$$

- Show that 74139 IC also works as a de-multiplexer.

THEORY:

74LS139 Decoder or De-multiplexer:

74LS139 consists of two separate 2-line to 4-line decoders in a single package. The active-low enable input can be used as a data line in de-multiplexing applications. All of these decoders/de-multiplexers have fully buffered inputs, presenting only one normalized load to its driving circuit. All inputs are clamped with high-performance Schottky diodes to suppress line-ringing and simplify system design. These Schottky-clamped circuits are designed to be used in high-performance memory-decoding or data-routing applications, requiring very short propagation delay times. In high-performance memory systems these decoders can be used to minimize the effects of system decoding. When used with high-speed memories, the delay times of these decoders are usually less than the typical access time of the memory. This means that the effective system delay introduced by the decoder is negligible.

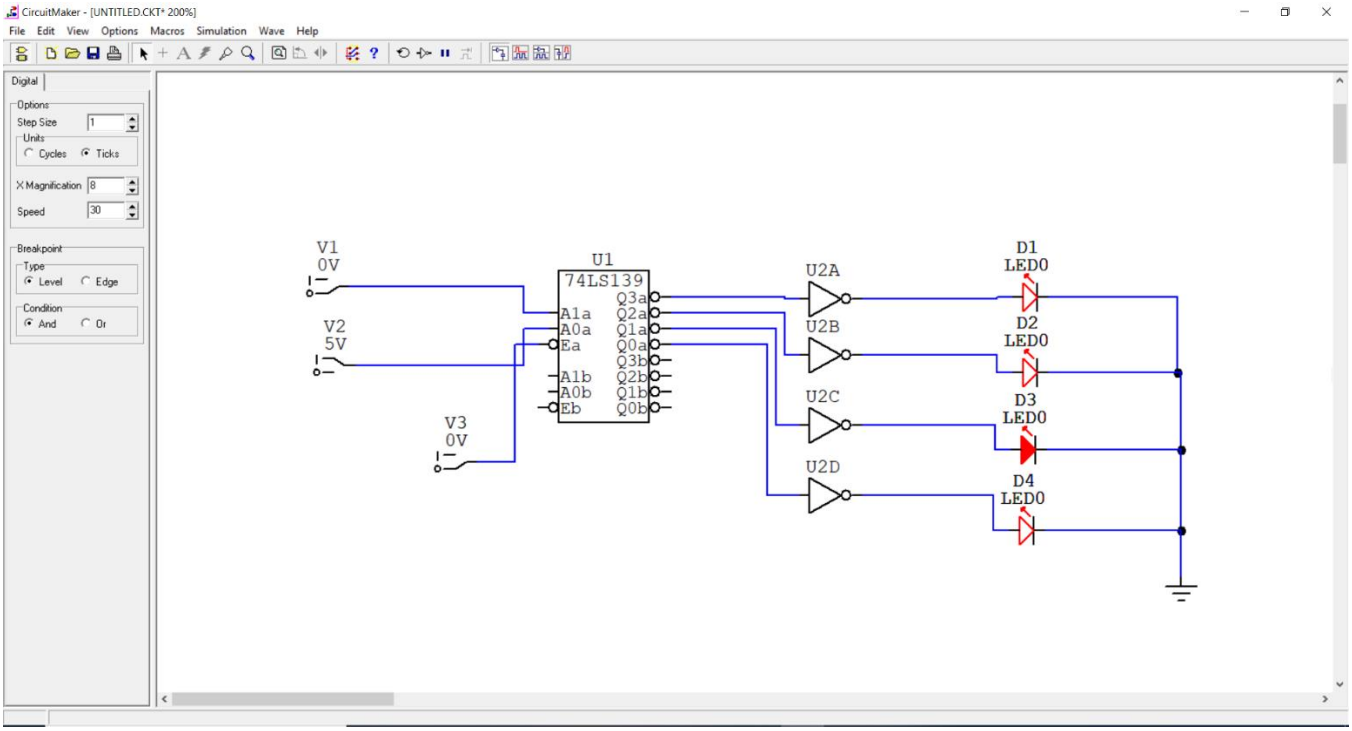
3 to 8 decoder:

3 to 8 decoder has 3 inputs and 8 outputs. Based on the 3 inputs one of the 8 outputs is selected.

LS139 decoder:

The LS139 is a high-speed dual 1-of-4 decoder/de-multiplexer fabricated with the Schottky barrier diode process. The device has two independent decoders, each of which accept two binary weighted inputs (A0, A1) and provide four mutually exclusive active LOW outputs (O0–O3). Each decoder has an active LOW Enable (E). When E is HIGH all outputs are forced HIGH. The enable can be used as the data input for a 4-output de-multiplexer application. Each half of the LS139 generates all four min terms of two variables.

1. Verify the TRUTH Table of 74139 IC (Dual 2-line to 4-line decoder):



Circuit Diagram of Dual 2-4 Decoder

Truth table for Dual 2-4 Decoder:

INPUT A	INPUT B	INPUT E	OUTPUT			
			L1	L2	L3	L4
x	x	1	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	1	0	0
1	0	0	0	0	1	0
1	1	0	0	0	0	1

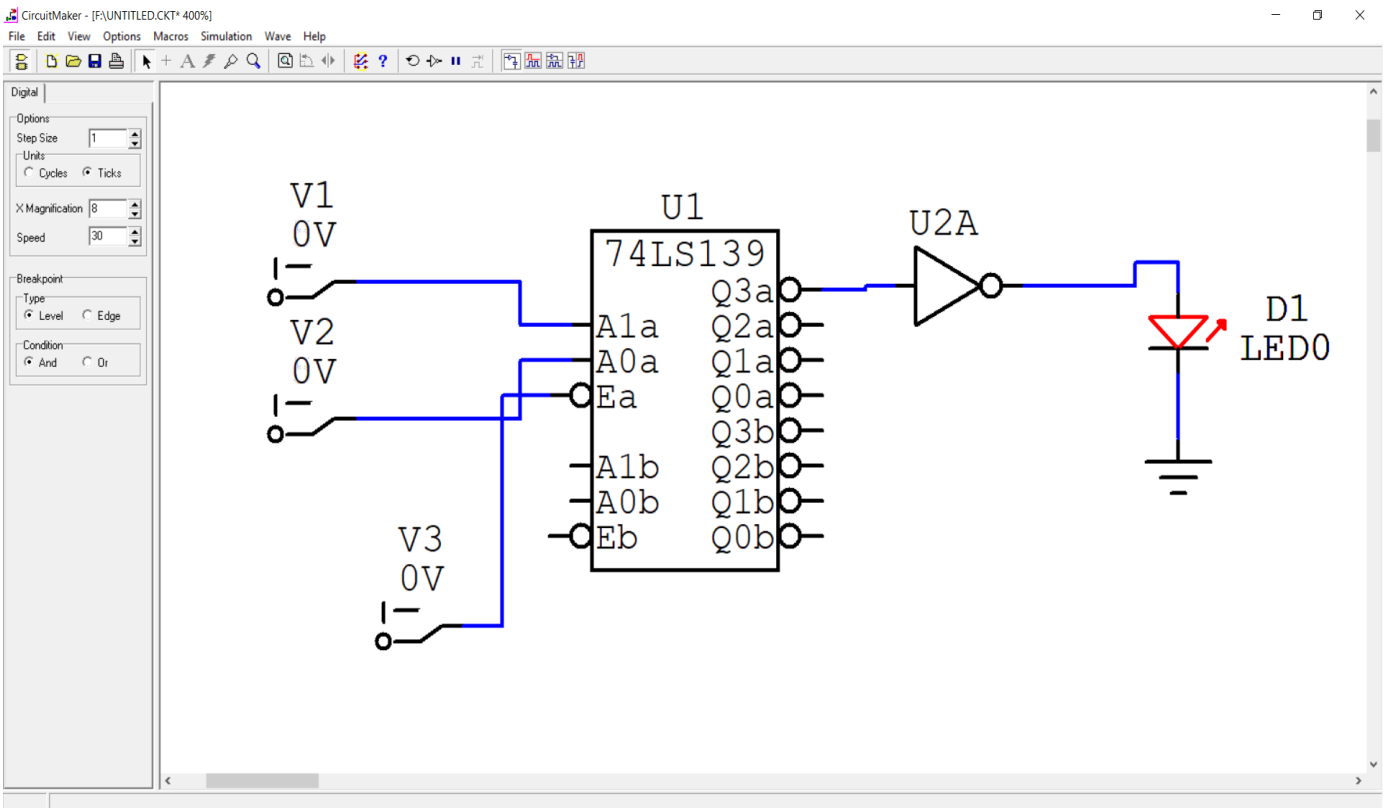
Hence the Truth Table is verified.

2. 74139 IC works as a universal logic block :

Truth Table for AND operation:

E	INPUT A	INPUT B	OUTPUT
1	x	x	0
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1

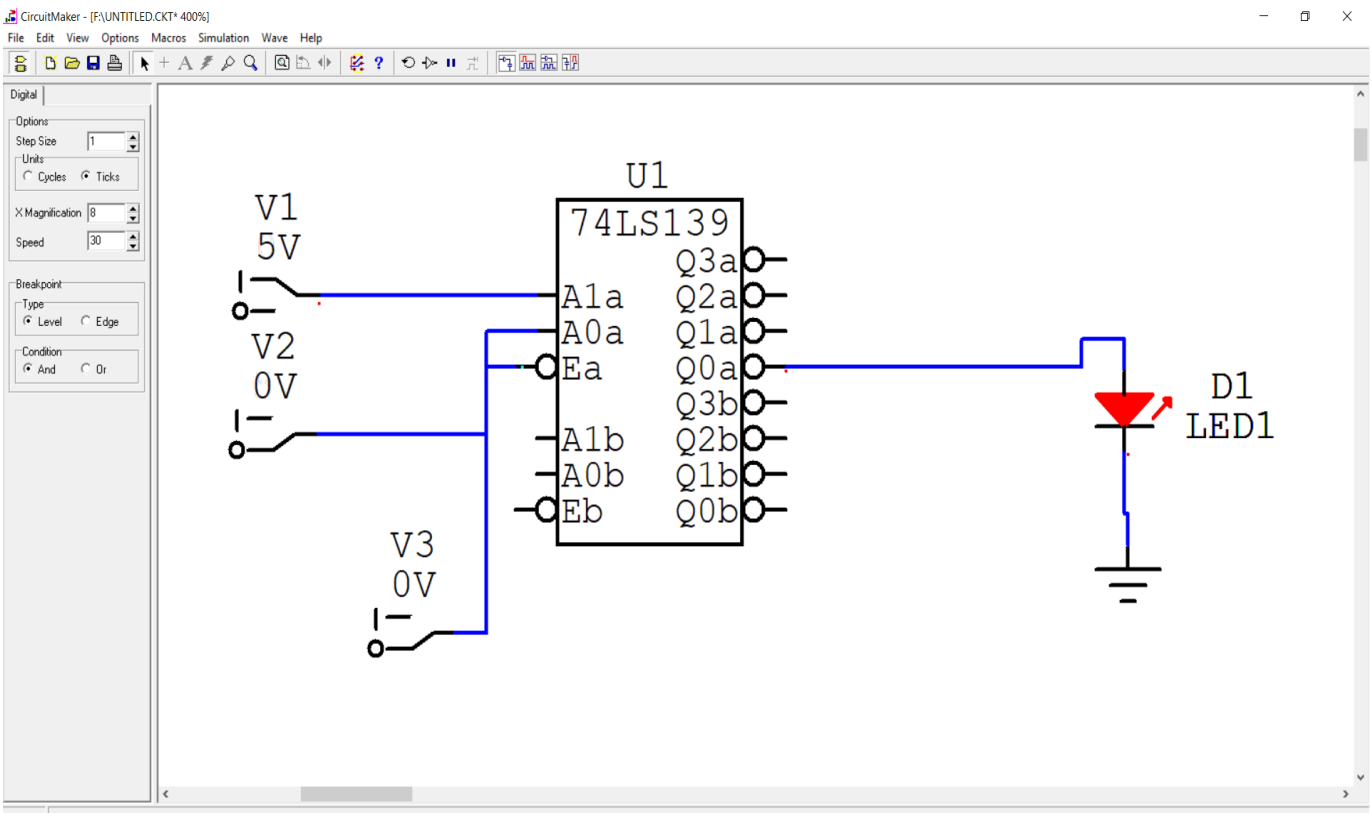
Circuit diagram for AND operation:



Truth Table for OR operation:

E	INPUT A	INPUT B	OUTPUT
1	X	X	0
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1

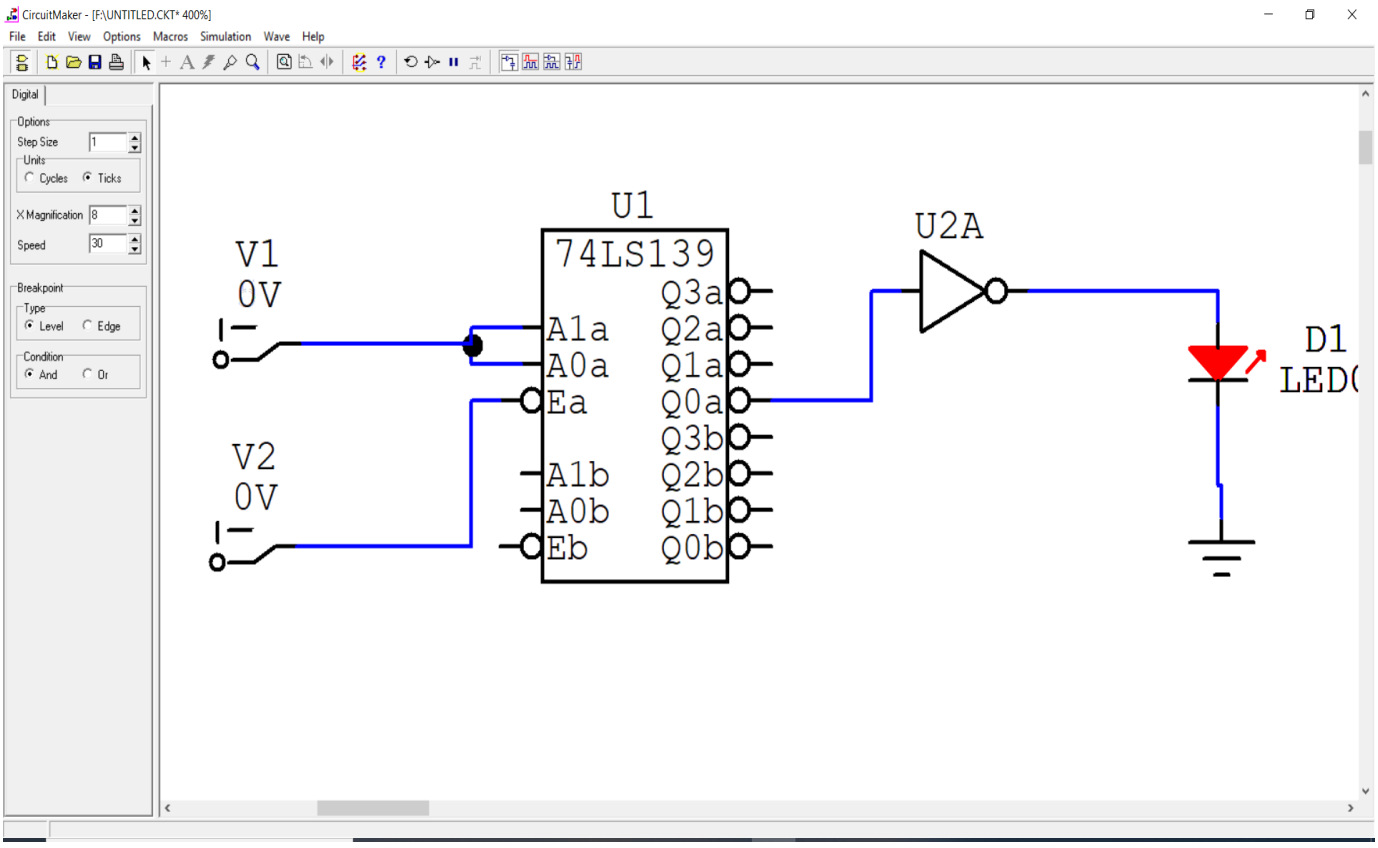
Circuit diagram for OR operation:



Truth Table for NOT operation:

INPUT A	E	OUTPUT
X	1	0
0	0	1
1	0	0

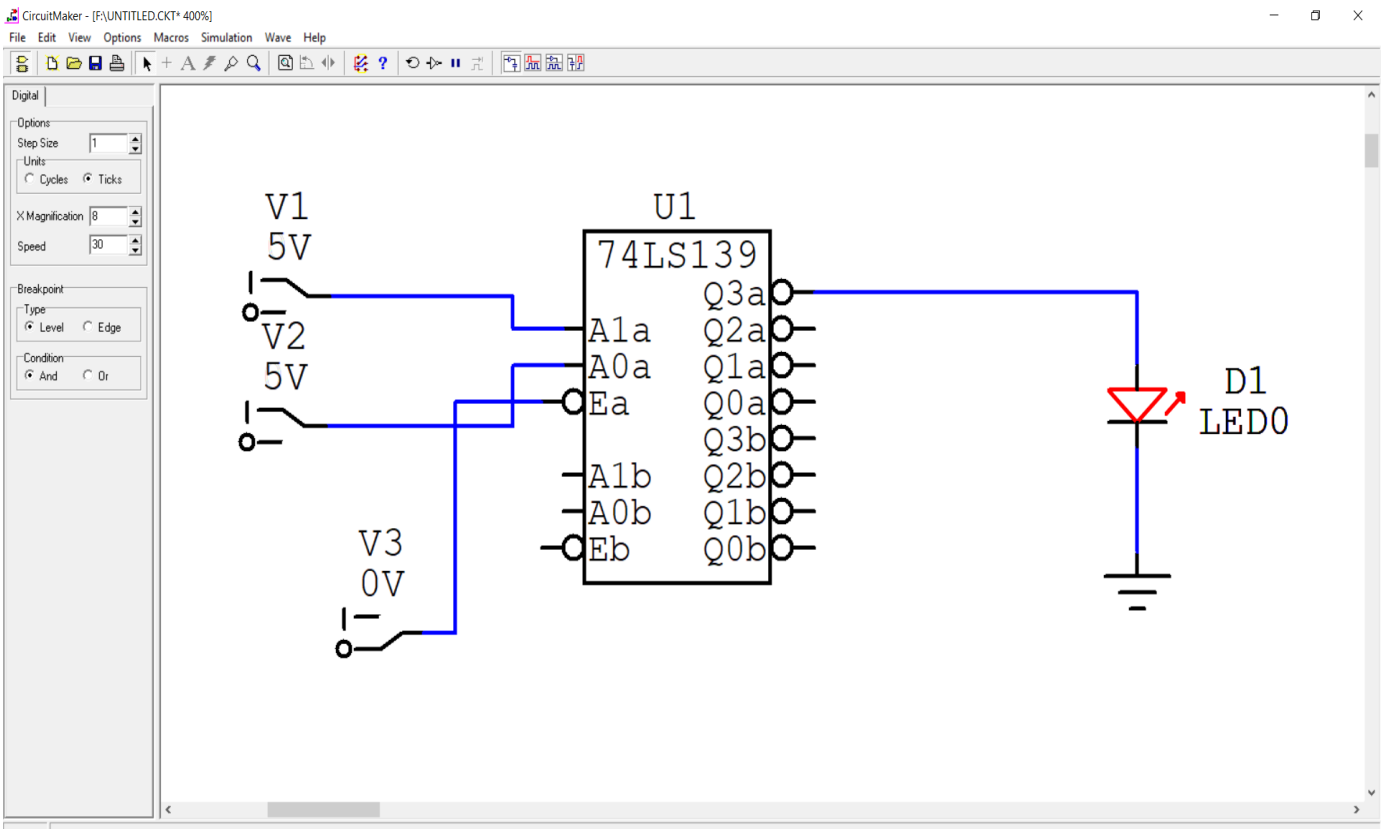
Circuit diagram for NOT operation:



Truth Table for NAND operation:

E	INPUT A	INPUT B	OUTPUT
1	X	X	0
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0

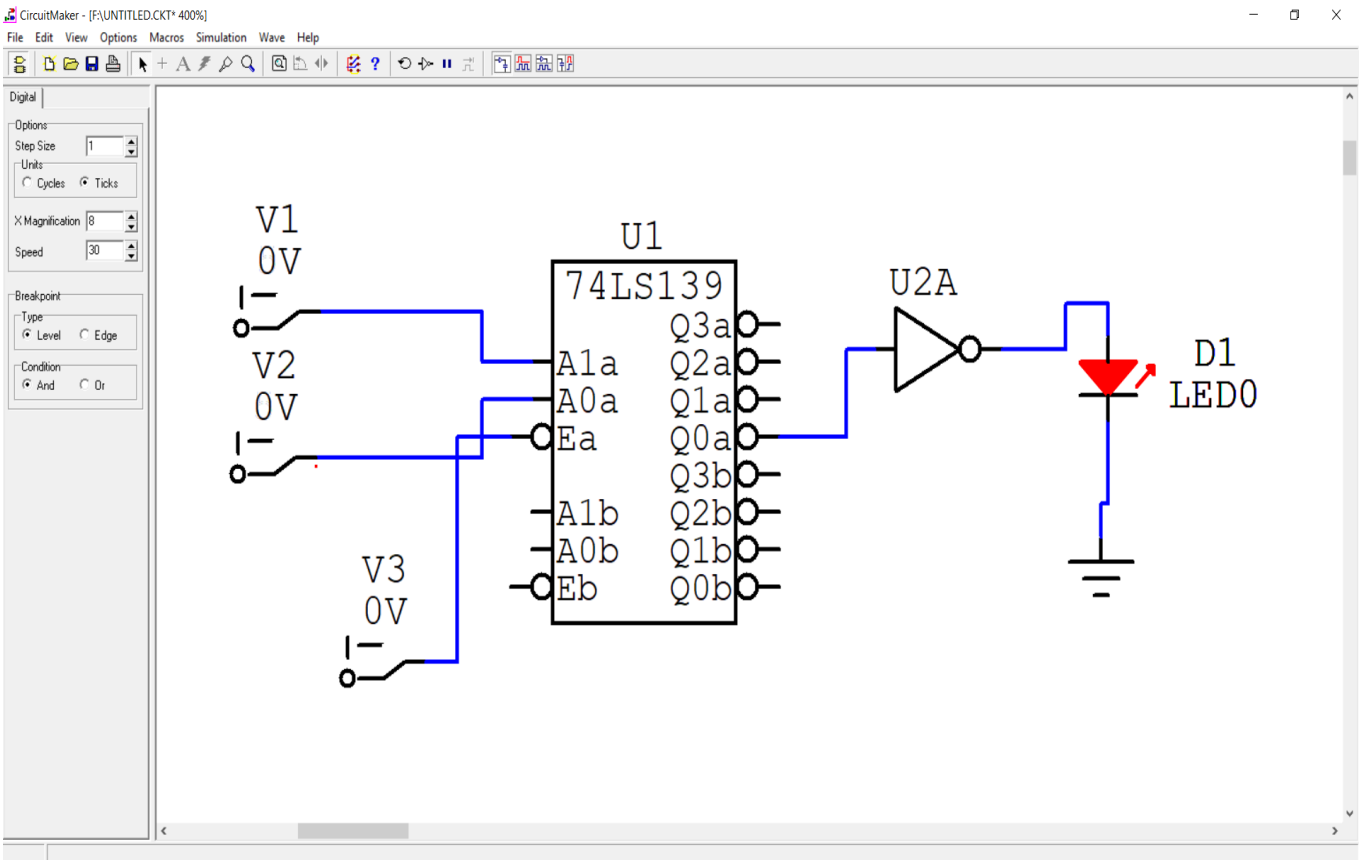
Circuit diagram for NAND operation:



Truth Table for NOR operation:

E	INPUT A	INPUT B	OUTPUT
1	X	X	0
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0

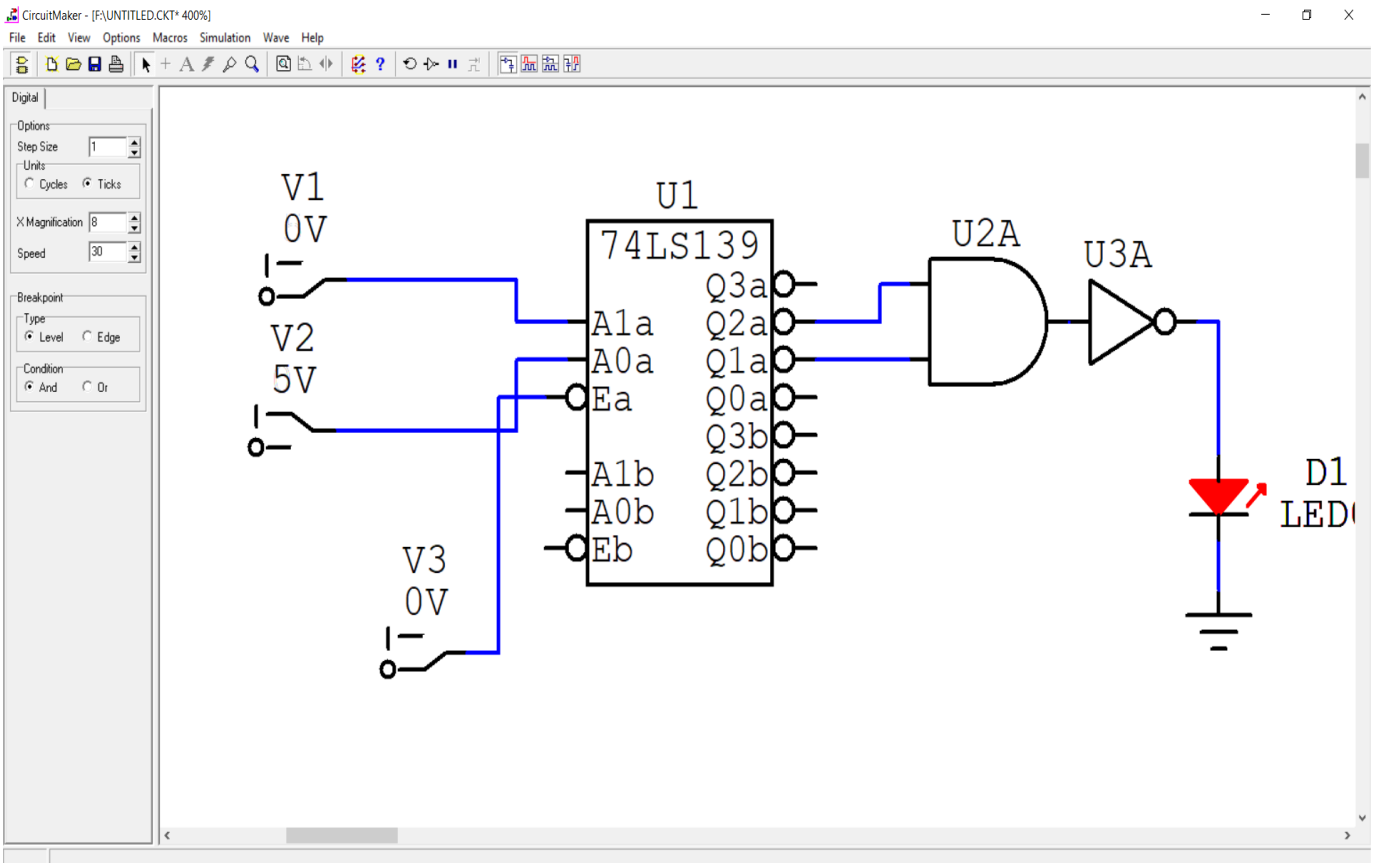
Circuit diagram for NOR operation:



Truth Table for XOR operation:

E	INPUT A	INPUT B	OUTPUT
1	X	X	0
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0

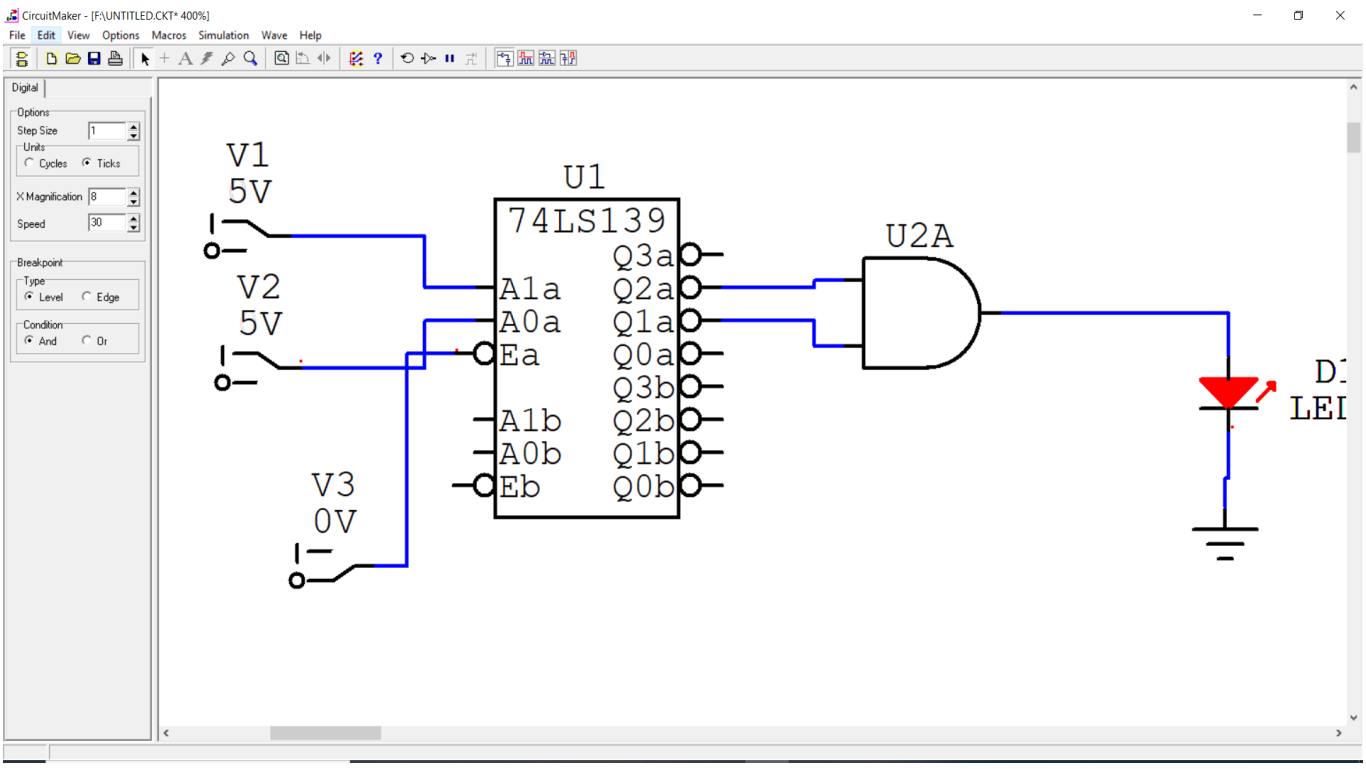
Circuit diagram for XOR operation:



Truth Table for XNOR operation:

E	INPUT A	INPUT B	OUTPUT
1	X	X	0
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1

Circuit diagram for XNOR operation:



Hence we can see that 74139 IC acts as a universal logic block gate with which all other basic gates can be implemented.

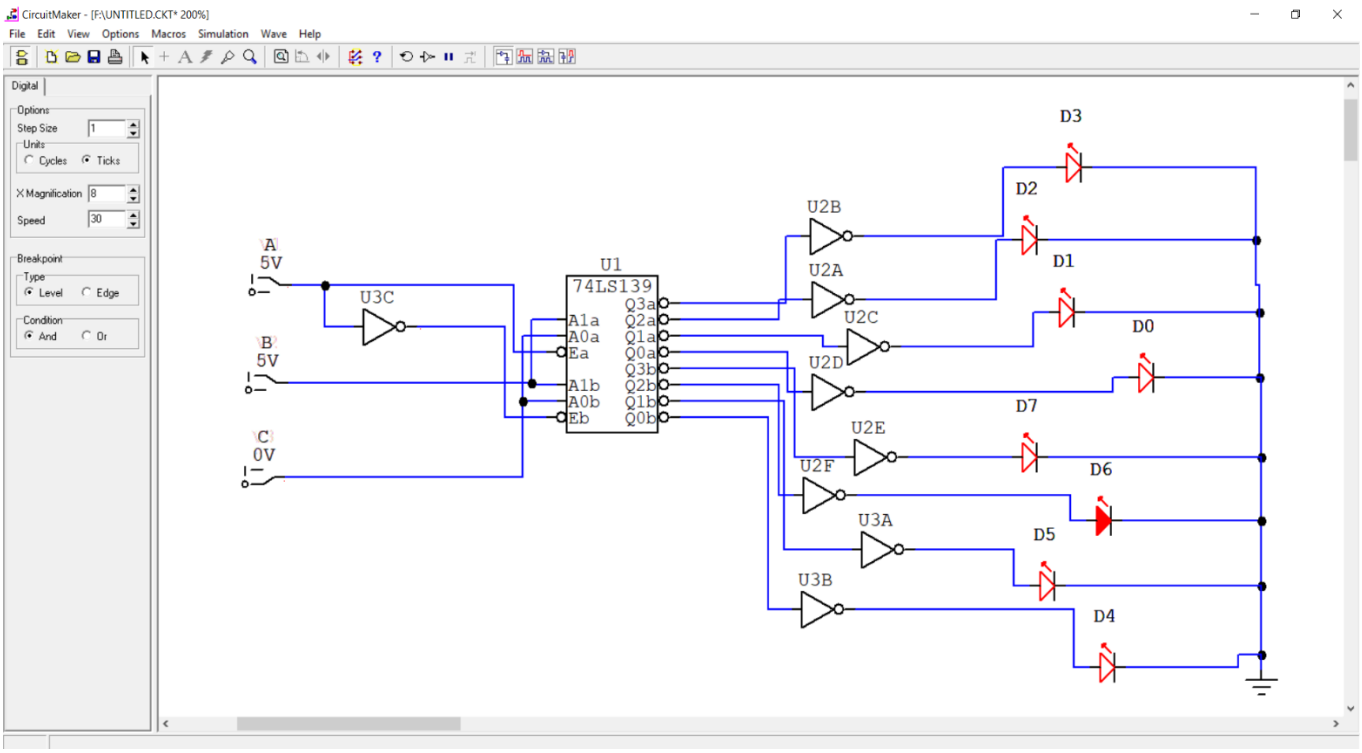
3. 3x8 decoder using two sections of a 74139 IC :

Truth Table of 3-8 Decoder:

A	B	C	D0	D1	D2	D3	D4	D5	D6	D7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

$$D0 = \overline{A}.\overline{B}.\overline{C},\ D1 = \overline{A}.\overline{B}.C,\ D2 = \overline{A}.B.\overline{C},\ D3 = \overline{A}.B.C$$
$$D4 = A.\overline{B}.\overline{C},\ D5 = A.\overline{B}.C,\ D6 = A.B.\overline{C},\ D7 = A.B.C$$

Circuit Diagram:



The truth table is verified.

Part 2 of the question,

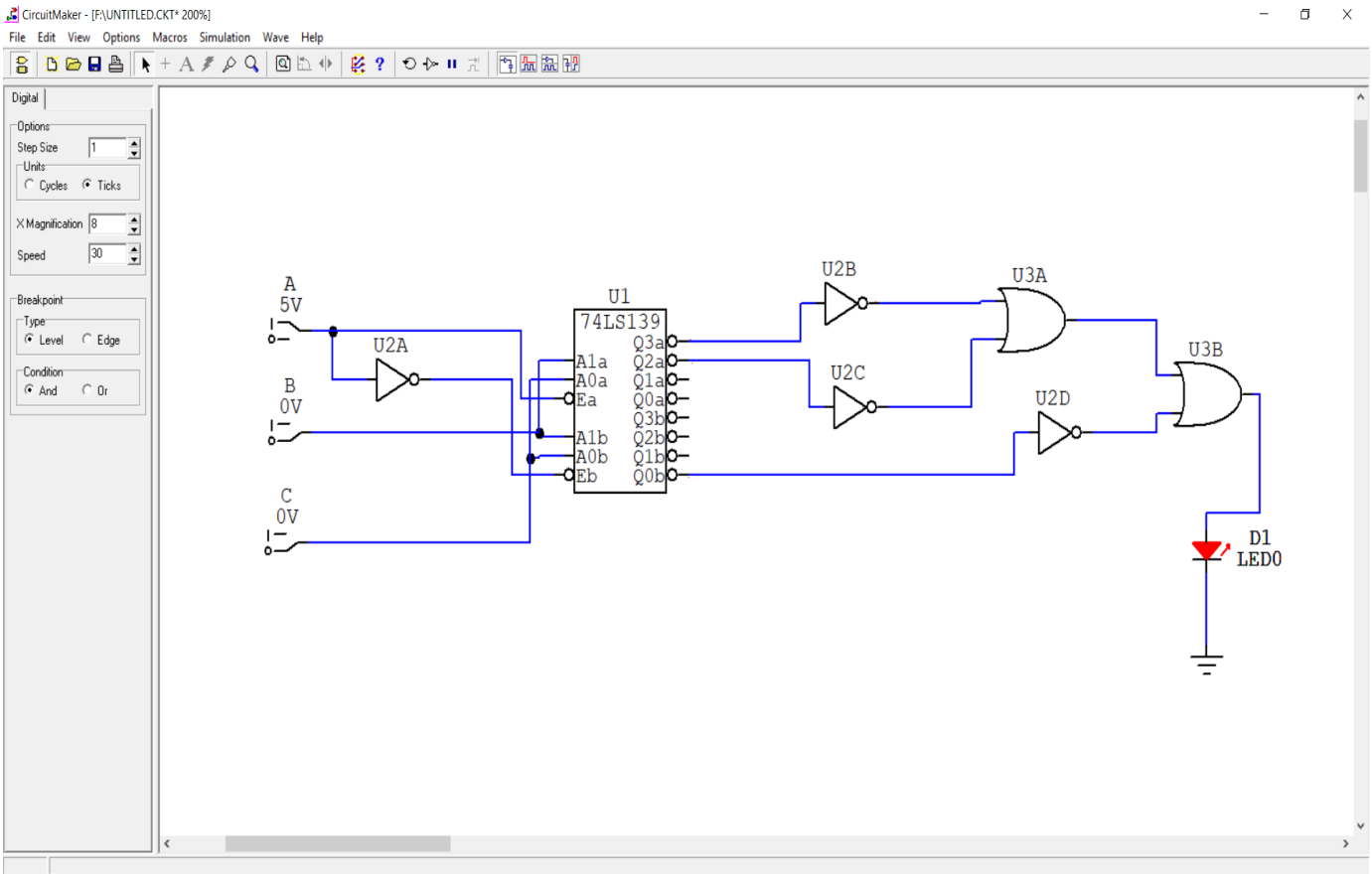
Truth Table:

INPUT A	INPUT B	INPUT C	OUTPUT $F = A.B.C + A.B$
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

We can construct the truth table in another way.

$$F(0,0,C) = 0$$
$$F(0,1,C) = 1$$
$$F(1,0,C) = \overline{C}$$
$$F(1,1,C) = 0$$

Circuit Diagram:



The Truth Table is verified. So, the Boolean logic equation is satisfied.

4. 74139 as a De-multiplexer :

Truth Table:

INPUT S0	INPUT S1	INPUT E	OUTPUT			
			Y3	Y2	Y1	Y0
0	0	D	0	0	0	D
0	1	D	0	0	D	0
1	0	D	0	D	0	0
1	1	D	D	0	0	0

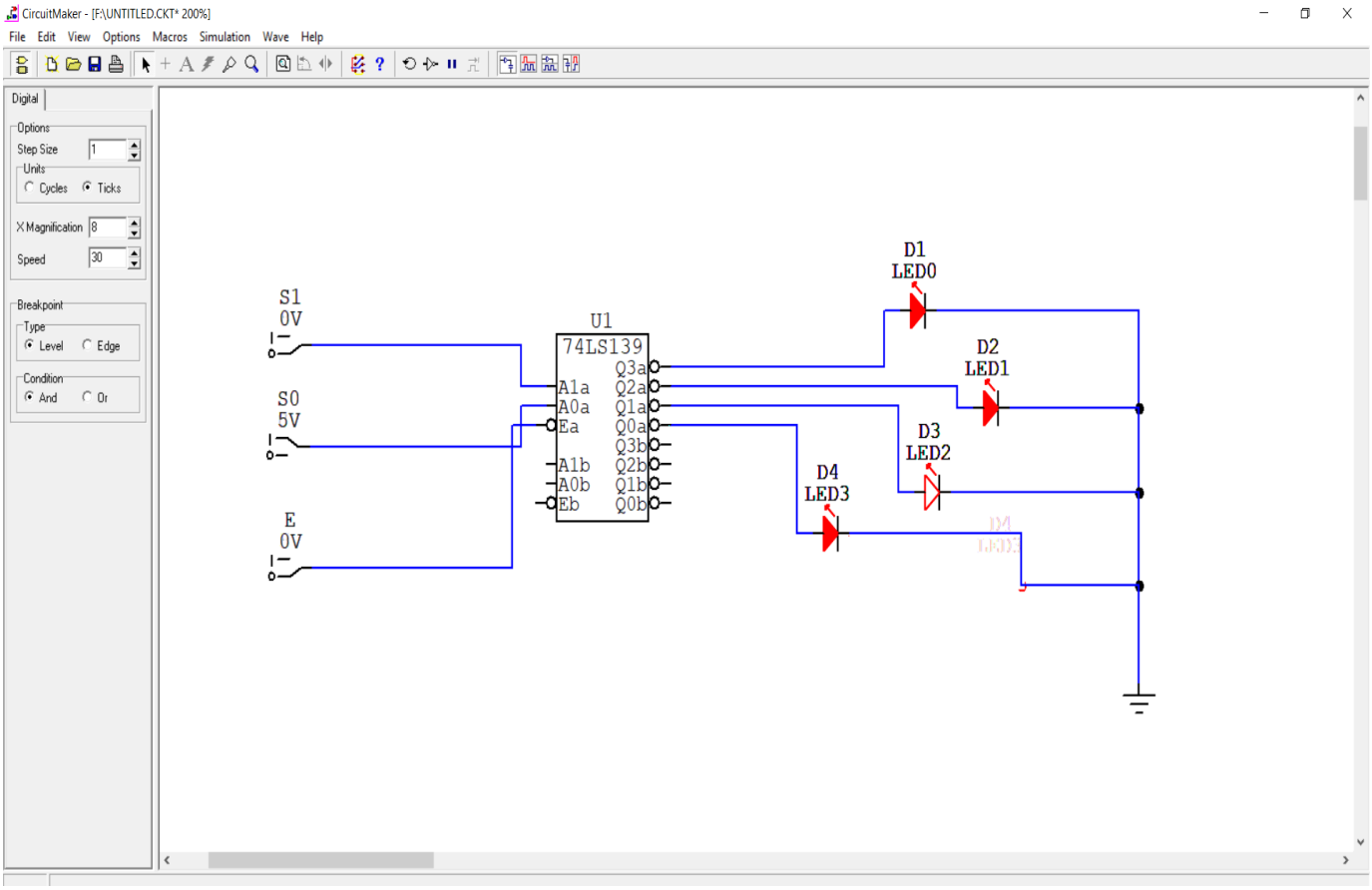
$$Y0 = \overline{S1}\ \overline{S0}\ D$$

$$Y1 = \overline{S1}\ S0\ D$$

$$Y2 = S1\ \overline{S0}\ D$$

$$Y3 = S1\ S0\ D$$

Circuit Diagram:



CONCLUSION:

74139 IC acts as a universal block IC with which we can construct basic logic gates and also circuits such as decoder and de-multiplexer, hence being able to design the circuit for various functions. The two segments of the IC can be conveniently used whenever required.