AIM

To implement the combinational logic for given function using basic gates/MSI ICs.
a. To study and verify the truth table of logic gates
b. To study the universal NAND and NOR gate

Software Required

MultisimLive Software

Theory

❖ Introduction to Logic Gates :

Logic gate is an elementary building block of a digital circuit. Most logic gates have two inputs and one output. At any given moment, every terminal is in one of the two binary conditions low (0) or high (1), represented by different voltage levels.

❖ Purpose of Logic gates :

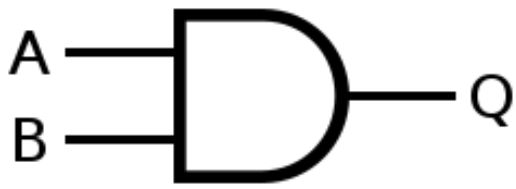
Logic gates perform logical operations on one or more binary inputs and produce binary output. We send information to devices using logical circuits which interpret the input of high (1) and low (0) voltages to give the required output.

❖ Application of Logic Gates :

Logic gates are used in microprocessors, microcontrollers and in electronic or electrical project circuits. These are also used in circuits involving computation and processing. Logic gates are used in push button switches, e.g. doorbell.

❖ Types of Logic Gate :

- **AND Gate:**
  It is a logic gate of which output is high(1) only when all the inputs are high(1).The logical expression is Y=A.B



Symbol

Truth Table

INPUT		OUTPUT
A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

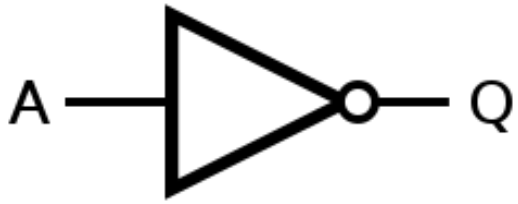
- **OR Gate:**
  The output will be zero if and only if both the inputs or at logic zero. The logical expression is Y=A+B

Truth Table

Symbol

INPUT		OUTPUT
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

- **NOT Gate:**
  This gate is always a single input gate it inverts the input in the output. Thus, it is also known as “The Inverter”.



Symbol

Truth Table

INPUT	OUTPUT
A	Q
0	0
1	1

- **NAND Gate:**
  The output will low when both the inputs are high.

Symbol

Truth Table

INPUT		OUTPUT
A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

- **NOR Gate:**
  The output will be high only when the inputs are low.

Symbol

Truth Table

INPUT		OUTPUT
A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

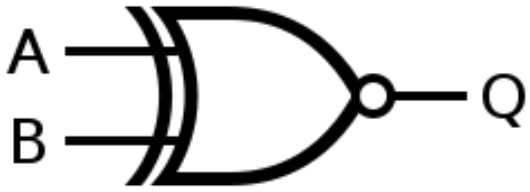
- **XOR Gate:**
  The outputs is low when both the inputs are low or high.

Symbol

Truth Table

INPUT		OUTPUT
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

- **XNOR Gate:**
  The output is high when all the inputs are high or low.



Symbol

Truth Table

INPUT		OUTPUT
A	B	Q
0	0	1
0	1	0
1	0	0
1	1	1

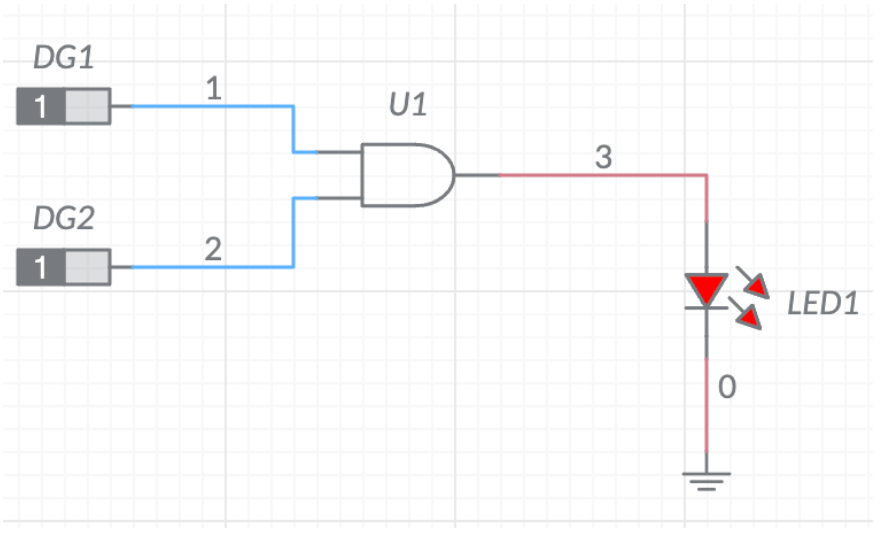
Procedure

1) Open a new circuit in Multisim

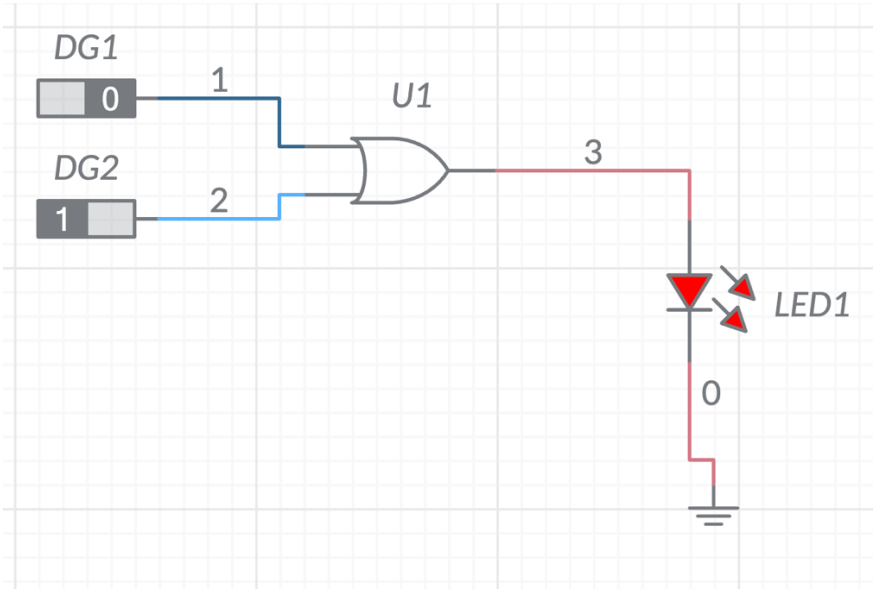
2) Click on Digital section from the left-side tools.
3) Choose the of required gate of 2 input and place in its places.
4) From the Digital section, choose digital constant.
5) Connect one of the digital constant to one of the inputs of the chosen gate.
6) Select another digital constant and connect it to the other input of the chosen gate.
7) Click on Indicator from the tools, select LED.
8) Connect the input of the LED to the output of the chosen gate.
9) Click on Schematic Connectors from the tools, click on Ground.
10) Connect the output of the LED to the ground.
11) To run the entire simulation/circuit, click on the play button 'Run Simulation'
12) We can verify the truth table by toggling the digital constant by making it 0 or 1.

Results and Observations

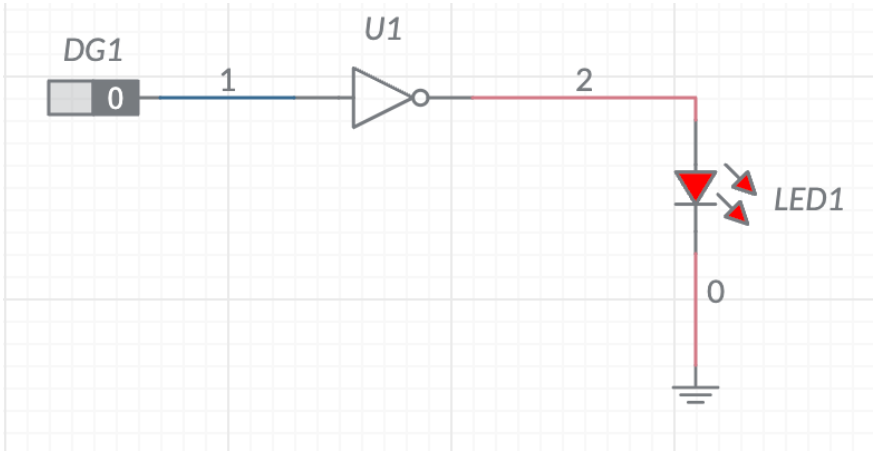
- **AND Gate**



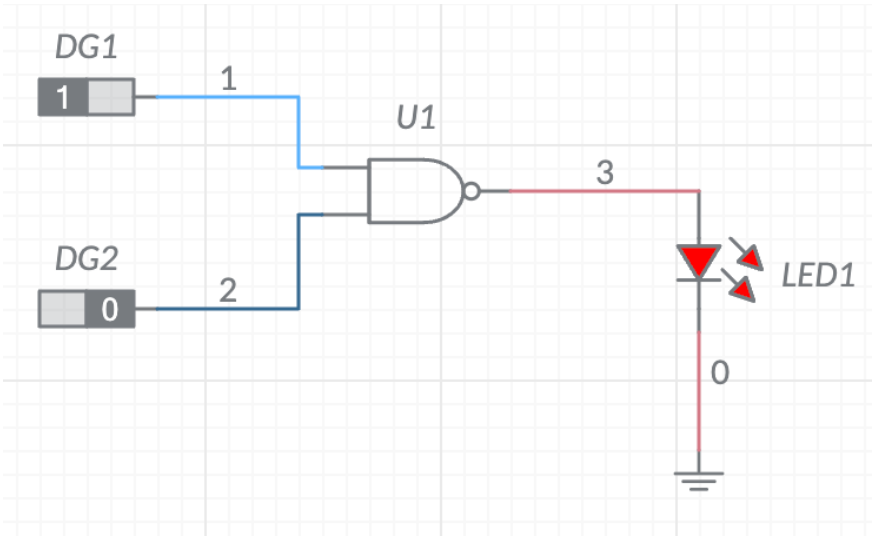
- **OR Gate**



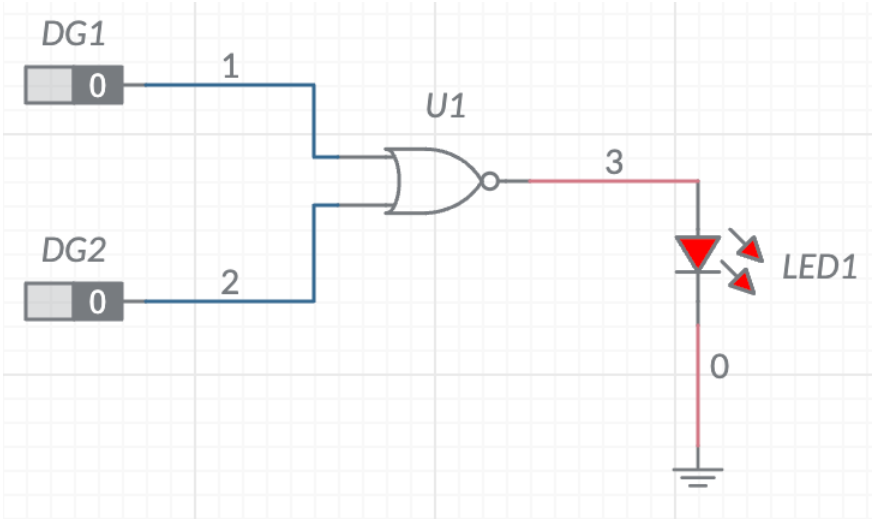
♦ **NOT Gate**



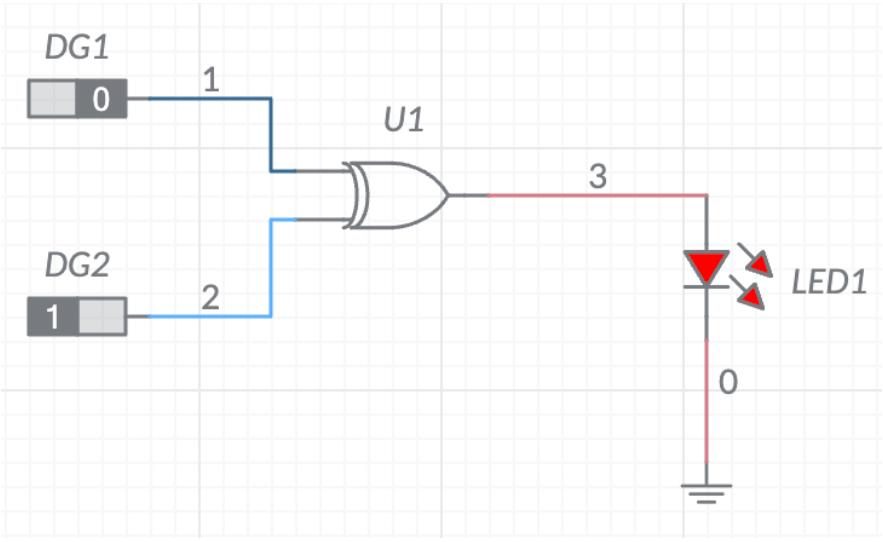
♦ **NAND Gate**



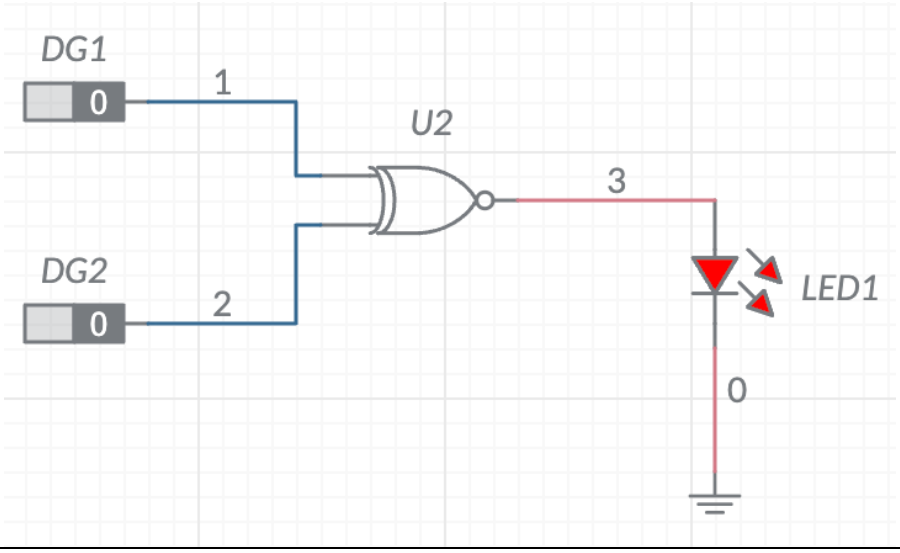
♦ **NOR Gate**



♦ **XOR Gate**



♦ **XNOR Gate**



Conclusion

We Conclude that, Logic Gates can be verified by the truth table, Boolean expression and Logic Diagram build in Multisim. Logic Gates give different output by changing values of inputs. They are used to develop varieties of IC circuits or microprocesses.

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AIM

To implement the combinational logic for given function using basic gates/MSI ICs.
c. To study the working of half adder, full adder, half subtractor, Full subtractor along with truth table

Software Required

MultisimLive Software

Theory

❖ Working:

- **Half Adder**: A half adder is an adder which adds two binary digits together, resulting in a sum and a carry.

- **Full Adder**: Full Adder is the adder which adds three inputs and produces two outputs. The first two inputs are A and B and the third input is an input carry as C-IN. The output carry is designated as C-OUT and the normal output is designated as S which is SUM.

- **Half Subtractor**: The half subtractor is also a building block for subtracting two binary numbers. It has two inputs and two outputs. This circuit is used to subtract two single bit binary numbers A and B. The 'diff' and 'borrow' are two output states of the half subtractor.

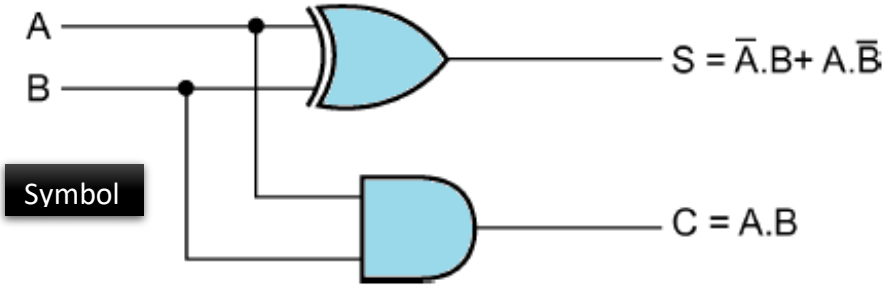
- **Full Subtractor**: A full subtractor is a combinational circuit that performs subtraction of two bits, one is minuend and other is subtrahend, taking into account borrow of the previous adjacent lower minuend bit. This circuit has three inputs and two outputs. The three inputs A, B and Bin, denote the minuend, subtrahend, and previous borrow, respectively. The two outputs, D and Bout represent the difference and output borrow, respectively.

❖ Truth Table and Symbol:

- **Half Adder:**

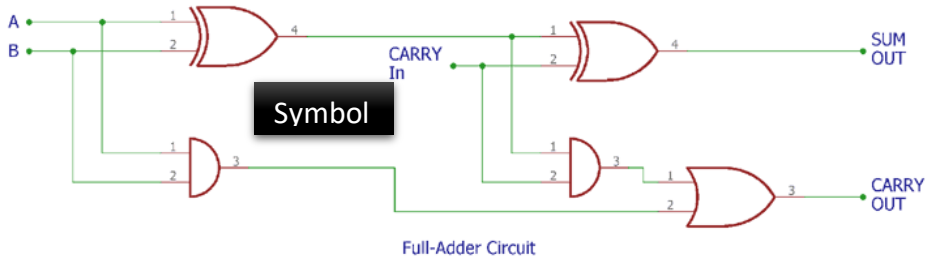
Truth Table

A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1



Symbol

- **Full Adder:**



Symbol

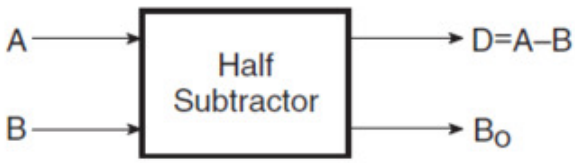
Truth Table

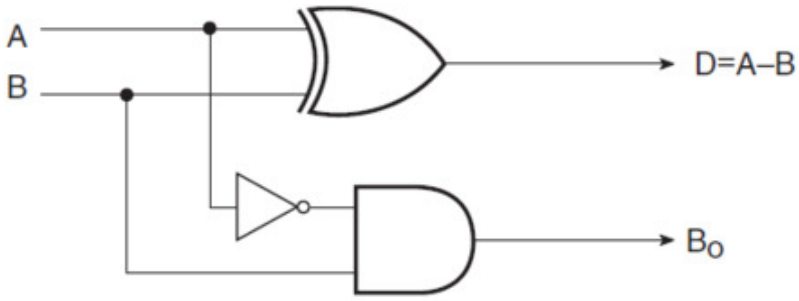
Inputs			Outputs	
A	B	C_{in}	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

- **Half Subtractor:**

Truth Table

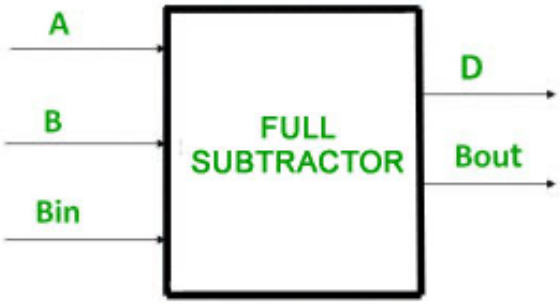
A	B	D	B_O
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0





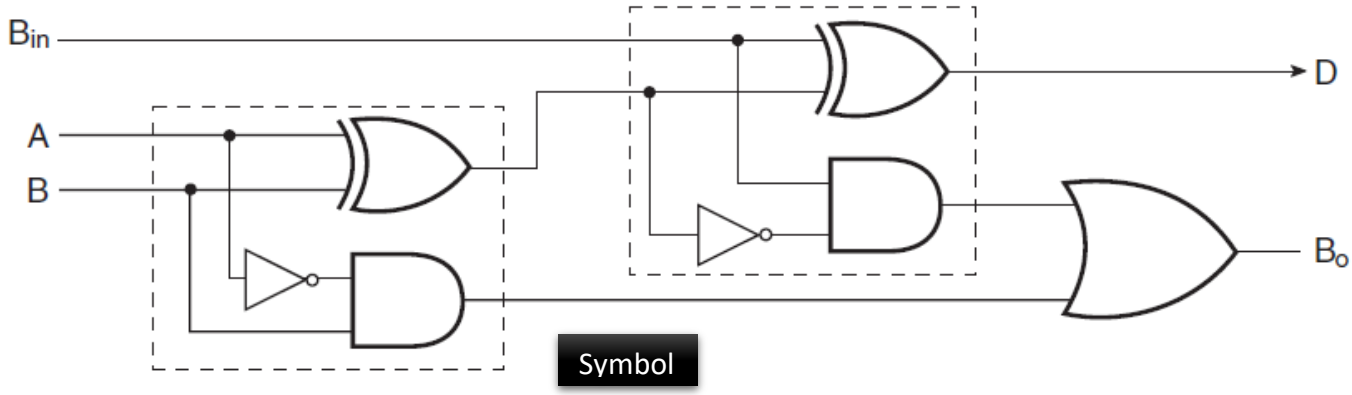
Symbol

- **Full Subtractor**:



Truth Table

INPUT			OUTPUT	
A	B	Bin	D	Bout
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1



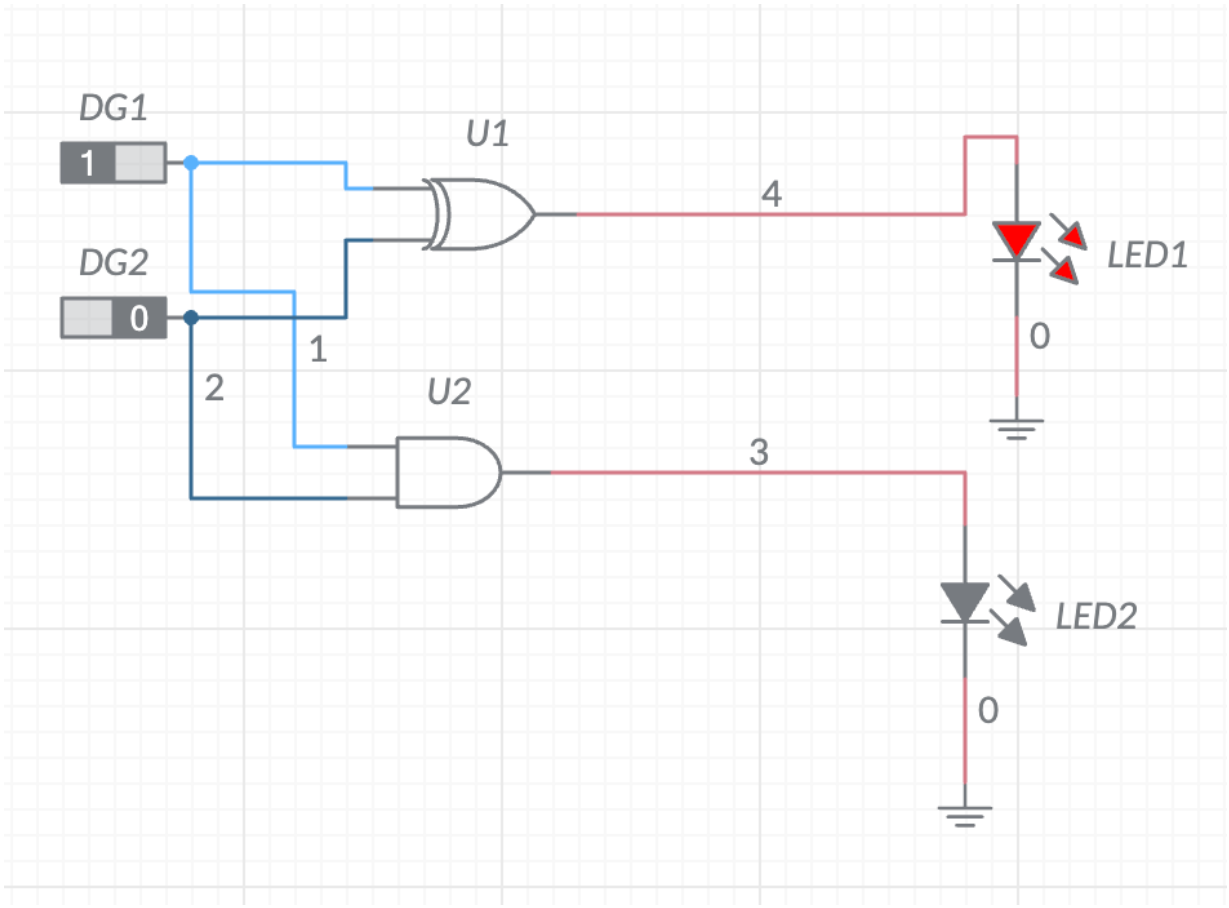
Symbol

Procedure

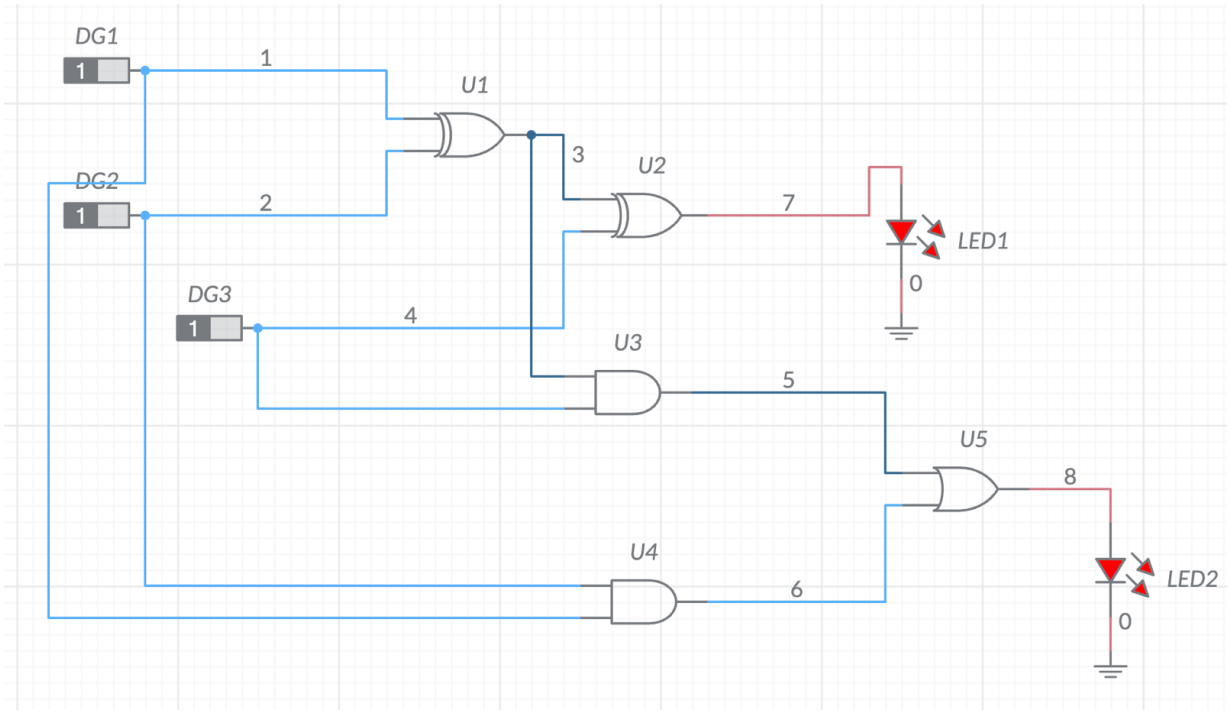
1. Open a new circuit in Multisim
2. Click on Digital section from the left-side tools.
3. Choose the required gate of 2-input
4. From the Digital section, choose digital constant.
5. Make the required connections with other gates, LEDs and toggle
6. Connect the output of the LED to the ground.
7. To run the entire simulation/circuit, click on the play button ‘Run Simulation’
8. We can verify the truth table by toggling the digital constant by making it 0 or 1.

Results and Observations

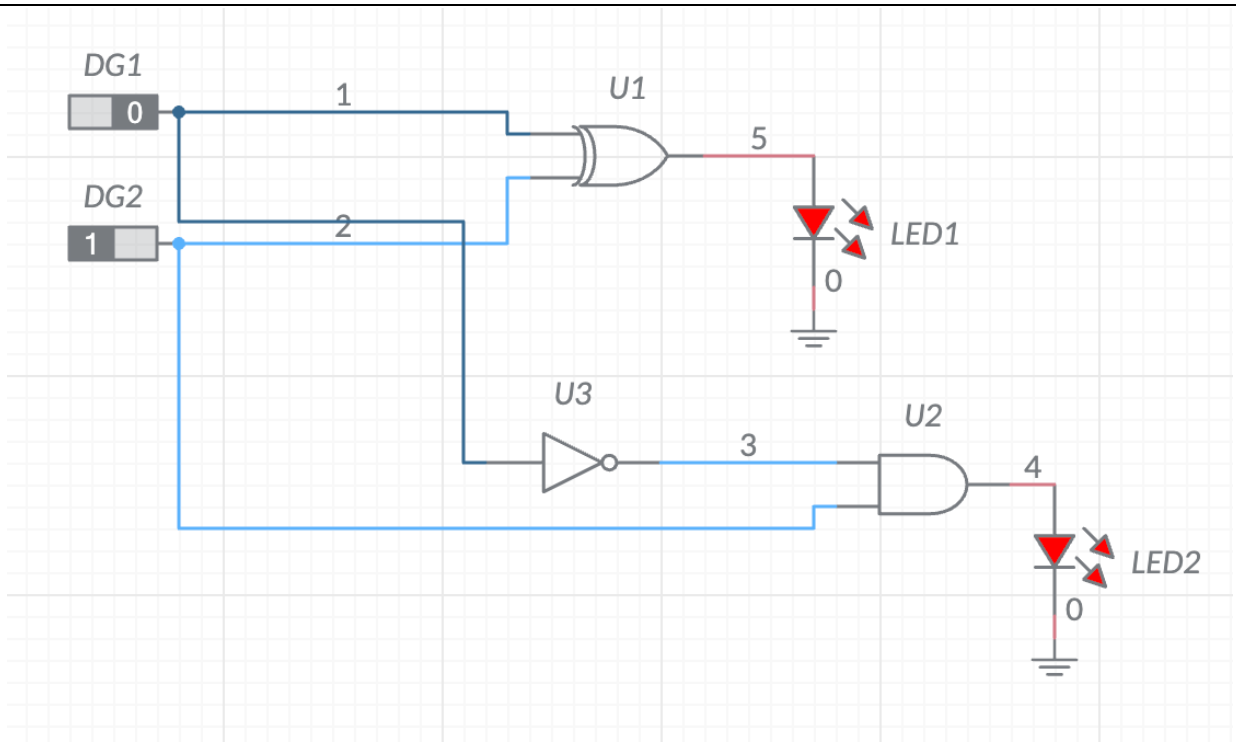
♦ **Half Adder**



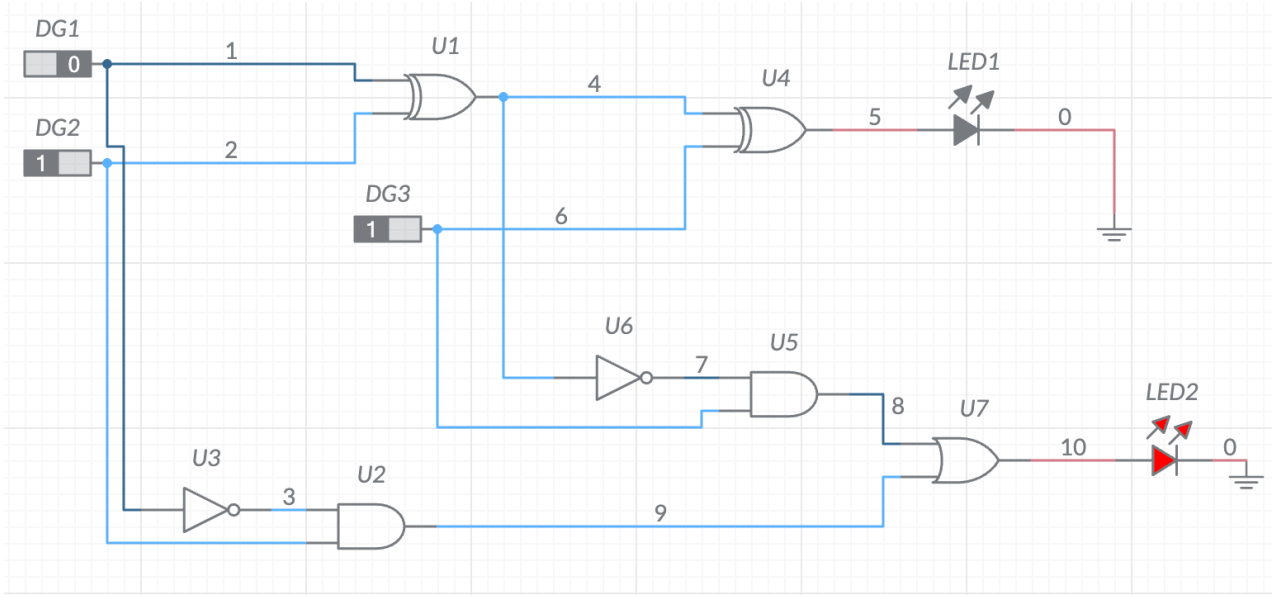
♦ **Full Adder:**



♦ **Half Subtractor:**



- **Full Subtractor:**



Conclusion

We Conclude that Half Adder incorporates XOR Gate for Sum and AND Gate for Carry. The Boolean expression is $A\bar{B}+\bar{A}B$ for Sum and $A.B$ for carry.
For Full Adder, the Boolean expression is $\bar{A}B\bar{C}+\bar{A}\bar{B}C+A\bar{B}\bar{C}+ABC$ for Sum and $AB+BC+CA$ for Carry.
Half Subtractor incorporates an XOR gate for difference and AND Gate for Borrow. The Boolean expression is $\bar{A}B+A\bar{B}$ for difference and $\bar{A}B$ for borrow
Full Subtractor has Boolean expression as follows: $(A \oplus B) \oplus C_{in}$ for Difference and $A.B + C_{in}(A \oplus B)$ for Borrow.