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Exp.no:1

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 gates

c. To study the working of half adder,full adder,half subtractor,full subtractor along with truth table.

Software required:

Multisimlive software

1) 7408 Quad 2 input IC (AND gate)

2) 7432 Quad 2 input IC (OR gate)

3) 7404 Quad 2 input IC (NOT gate)

4) 7400 Quad 2 input IC (NAND gate)

5) 7402 Quad 2 input IC (NOR gate)

6) 7486 Quad 2 input IC (XOR gate)

7) 747266 Quad 2 input IC (XNOR gate)

8) Logic toggle

9) LED

10) Ground

Theory:

- ### Introduction to logic gates:

A logic gate is a digital circuit,with only one output and one or more inputs.They generally operate on one of the two states known as on(1) and off(0).The relationship between the input and the output is based on a certain logic.

There are two types of gates:

1.Fundamental gates

They include and,or and not gates

2.Derived gates

They include Nand,Nor,Ex-or,gates etc.

Nand and Nor are also called the universal building blocks.

- ### Purpose of logic gates

Logic gates perform logical functions based on the binary input and produce binary output either 0 or 1.It is an idealized model of computation of physical electronic device implementing a Boolean function

- ### Application of logic gates

Logic gates found application in microprocessors,electrical project circuits,microcontrollersetc.Nand gates are used in burglar alarms and buzzers.

Ex-or and Ex-nor gate are used in parity generation and checking units.

- Half Adder:A half adder is a combinational logic circuit that adds two binary digits and produces a sum and carry as output.This circuit has two inputs and two outputs and is constructed by using a and gate as carry and the Ex-or gate as sum.
- Half subtractor: :A half subtractor is a combinational logic circuit that subtracts two binary digits and produces a difference and borrow output.this circuit has two inputs A(minuend)and B(subtrahend) and and has two outputs.
- Full adder: A Full adder is a combinational logic circuit that adds three binary digits and produces a sum and carry as output.A and B are the input variables that represent

two significant bits that are going to be added,Cin is the third input which represents carry, it is fetched from the lower significant position. The eight rows represent all possible combination of 0 and 1 that can occur in these variables.

- Full subtractor: A Full subtractor is a combinational logic circuit that subtracts two binary digits and produces a difference and borrow as output. A and B are the input variables that represent two significant bits that are going to be subtracted, borrowin is the third input which represents borrow. The eight rows represent all possible combination of 0 and 1 that can occur in these variables.

- Procedure:

1.Open a new tab in google chrome.

2.Type multisim online and open it.

3. Click on create circuit to create a new circuit in multisim.
4.Click on digital symbols from the tools given on the left.

5.Click and drag required digital constants from the digital section onto the screen.

6.Choose the required logic gate.

7.Click and drag LED onto the screen from indicators.

8. Click and drag ground from the schematic connectors.

9.Connect the digital constants to the inputs and connect the output of the gate to one end of the led and the other end to ground.

10.Make the required connections to make logic circuit of your choice.

11.To run the logic circuit click on the play button.

12.Now we can verify the truth tsble by changing the values of the digital constants.

Logic gates (AND, OR, NOT, NAND, NOR,EXOR, XNOR) :

1. Add the required gates with 2 inputs or a single input(depends on the type of gate) and

1 indicator LED for the output in the workspace.

2. Connect the inputs of the gates to the digital inputs.

3. Connect the output of the gate to the LED.

4. Connect the LED outputs to the ground.

5. Test the circuit.

Half adder :

1. Add 2 inputs A (DG1) and B (DG2), 5 NAND gates, two indicator LEDs for

output Sum (LED1) and Carry (LED2) in the workspace.

2. Connect two input terminals of U1(NAND gate) and one input terminal of U2(NAND gate) and U3(NAND gate) to the digital inputs.

3.Make the required connections of wires between the NAND gates.

4. Make connections of the NAND gates (U4 and U5) to the LEDs which represent Sum and Carry respectively.

5. Connect the LED outputs to the ground.

6. Test the circuit.

Half Subtractor :

1. Add 2 inputs A (DG1) and B (DG2), 5 NAND gates, two indicator LEDs for

output Sum (LED1) and Carry (LED2) in the workspace.

2. Connect two input terminals of U1(NAND gate) and one input terminal of U2(NAND gate) and U3(NAND gate) to the digital inputs.

3. Make the required connections between the NAND gates.

4. Make connections of the NAND gates (U4 and U5) to the LEDs which represent Sum and Carry respectively.

5. Connect the LED outputs to the ground.

6. Test the circuit.

Full adder :

1. Add 2 EXOR gates, 2 AND gates,1 OR gate (all gates with two

inputs), three inputs- A,B,C ; two LEDs at output for Difference (D) and

Borrow (Bout) to the workspace.

2.Connect both the inputs of U1(EX-OR),U4(AND)and one input of U2(EXOR) and U3(AND) to the digital inputs.

3. Make the required connections between all the gates.

4.Connect the output of U2(EXOR) and U5(OR) to the LEDs.

5. Connect the LED outputs to the ground.

6. Test the circuit.

Full subtractor :

1. . Add 2 NOT gates,2 EXOR gates, 2 AND gate and 1 OR gate (all gates with two

inputs), three inputS DG1,DG2,DG3 ; two indicator output LEDs for Difference (D) and

Borrow (Bout).

2. Connect the input DG3 to U1(EXOR), U3(AND), input DG1, DG2 to U1(EXOR),U2(NOT),U4(EXOR), and U6(AND).

3. Make the required connections between all the gates.

4. Connect the output of U4(EXOR) and U7(OR) to LEDs

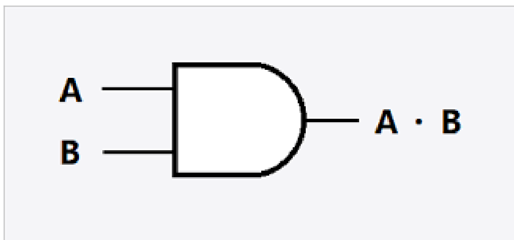
5. Connect the LED outputs to the ground.

6. Test the circuit.

Results and observations:

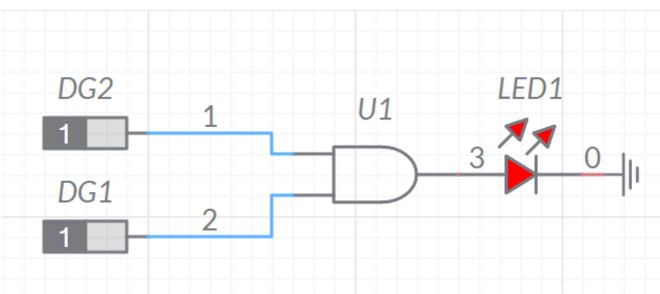
1.AND gate:

This gate gives high output only when both the inputs are high.The logical expression is Y=A.B.



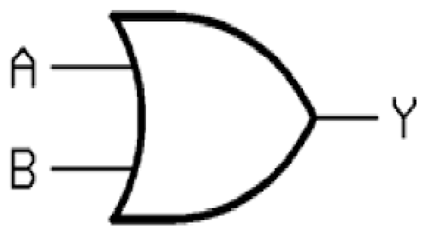
Inputs		Output
A	B	Y=A.B
0	0	0
0	1	0
1	0	0
1	1	1

Truth table



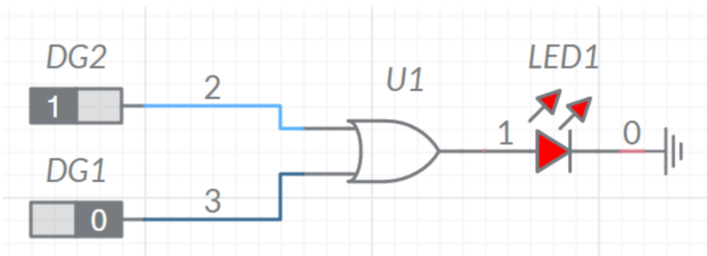
2.OR gate:

This gate gives high output when any one of the inputs are high and gives low output when both the outputs are low.The expression is Y=A+B.

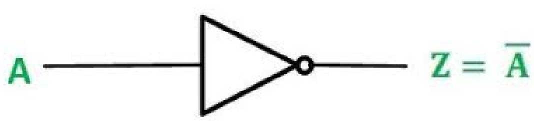


Inputs		Output
A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

Truth table

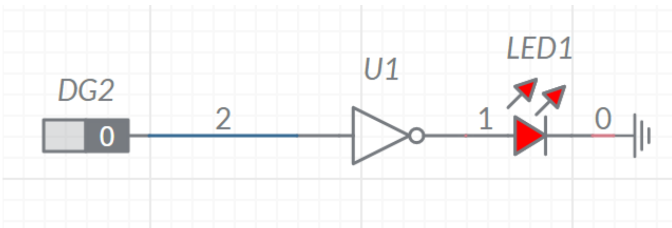


<u>3.NOT gate</u>:This gate inverts the input,hence it's also called as inverter.It has one input and one output.It's expression is Y=A'



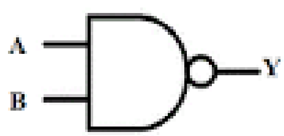
Truth Table	
A	A'
1	0
0	1

Truth table



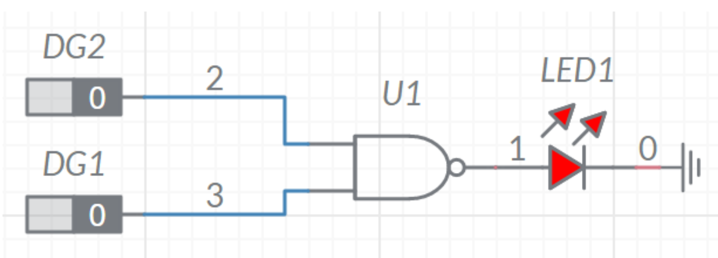
4.NAND gate:

This gate gives low output when all inputs are high .In simple words it gives Not And type of Output.



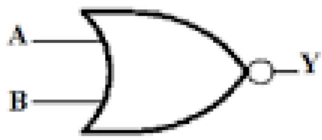
Inputs		output
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Truth table



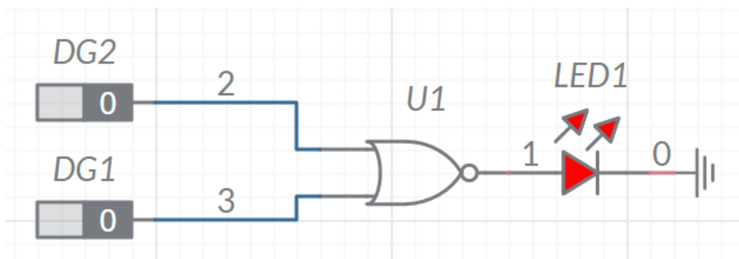
5.NOR gate:

This gate gives high output when all the inputs are low.In simple words this gate gives Not or type of output.The Nor gate is also called as the Universal building block because all other type of gates can be constructed using this gate.



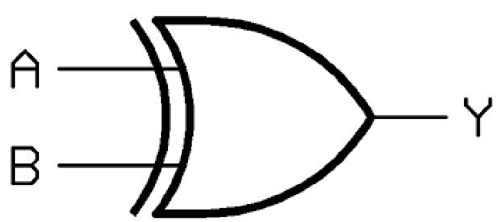
inputs		output
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Truth table



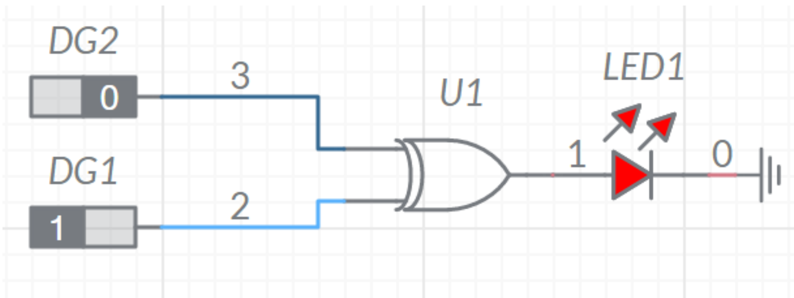
<u>6.EX-OR gate</u>:

This gate gives high output only when there are odd no. of 1's in input.this gate is also called parity checker.



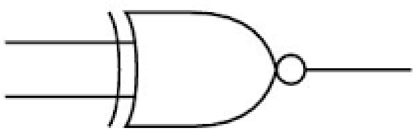
A	B	Output
0	0	0
0	1	1
1	0	1
1	1	0

Truth table

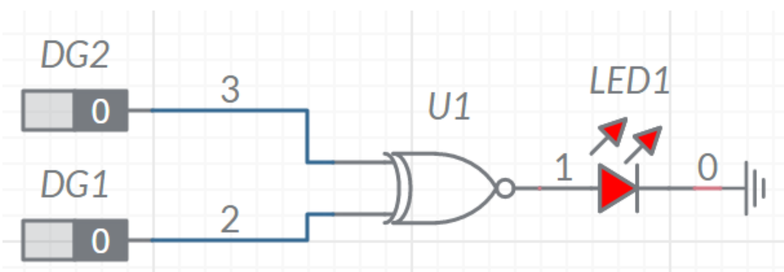


7.EX-NOR gate:

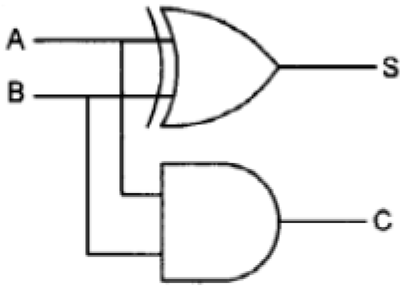
This gate high output only when there are even no. of 1's in input.This gate is the complement of EX-OR gate.



A	B	Z=A⊙B
0	0	1
0	1	0
1	0	0
1	1	1

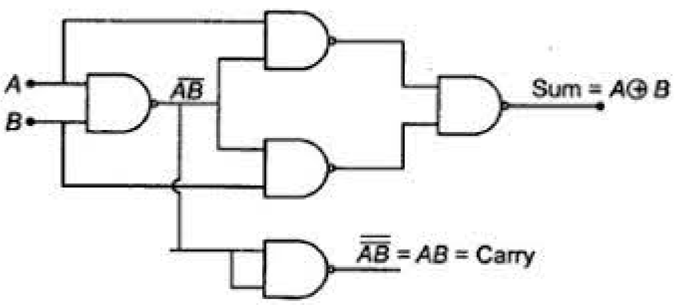


HALF ADDER:

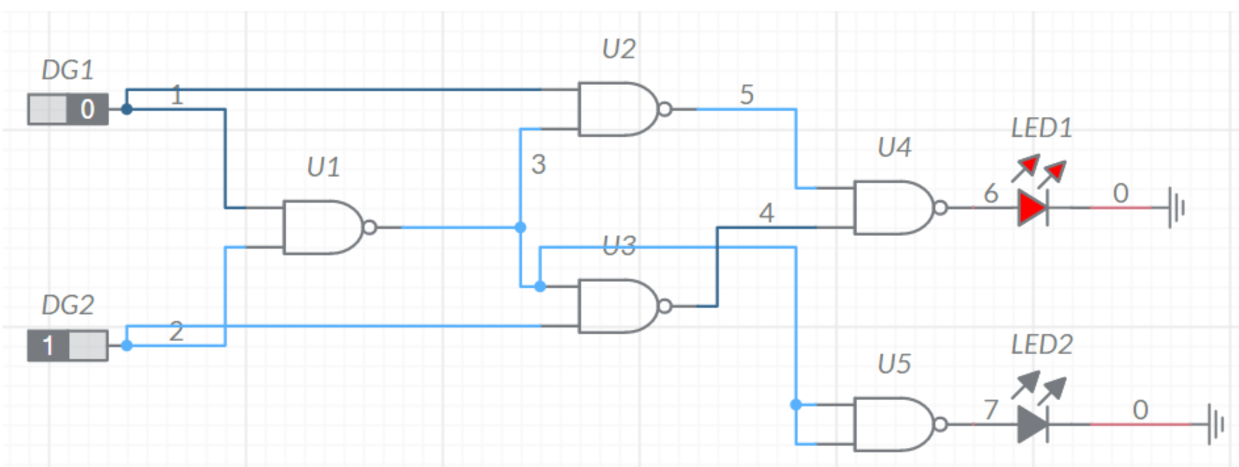


Input		Output	
A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

CIRCUIT OF:HALF ADDER

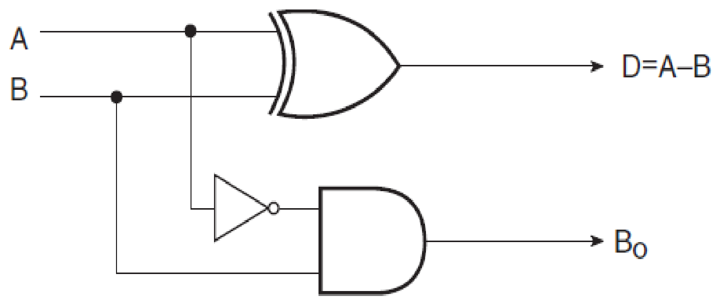


CIRCUIT OF:HALF ADDER USING NAND GATES



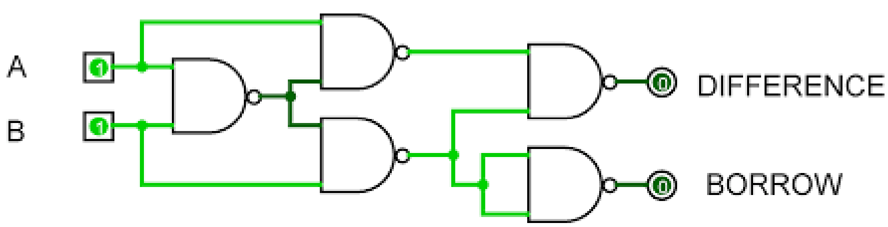
SIMULATION OF HALF ADDER

HALF SUBTRACTOR:

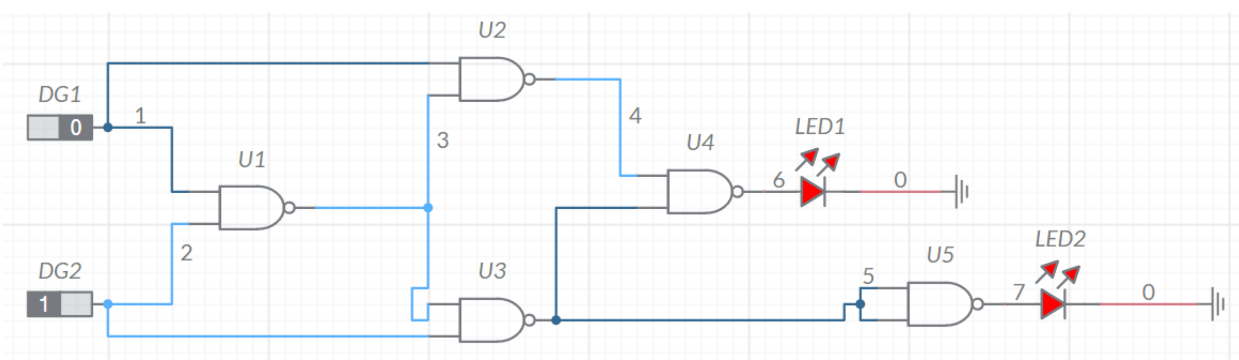


CIRCUIT OF:HALF SUBTRACTOR

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

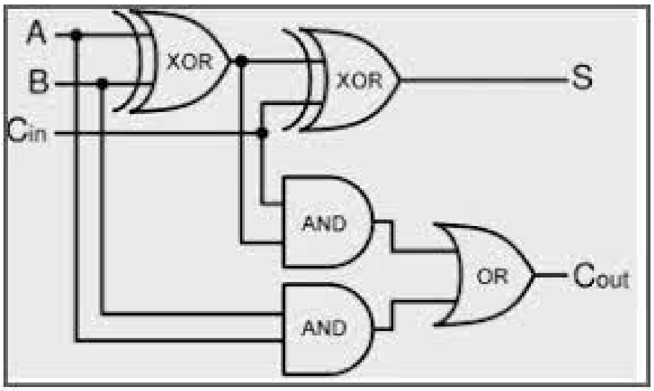


CIRCUIT OF: HALF SUBTRACTOR USING NAND GATES



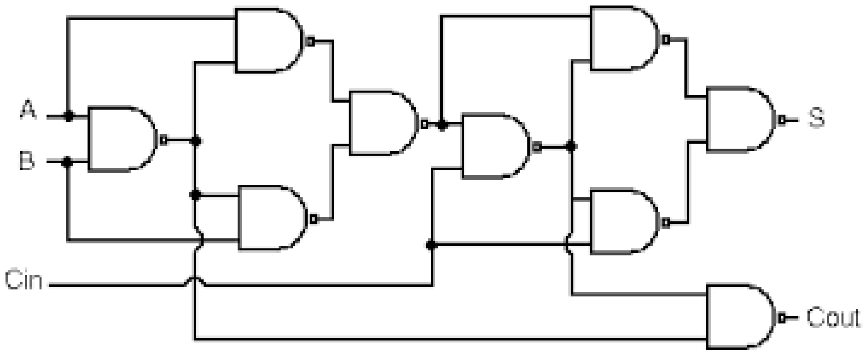
SIMULATION OF HALF SUBTRACTOR

FULL ADDER:

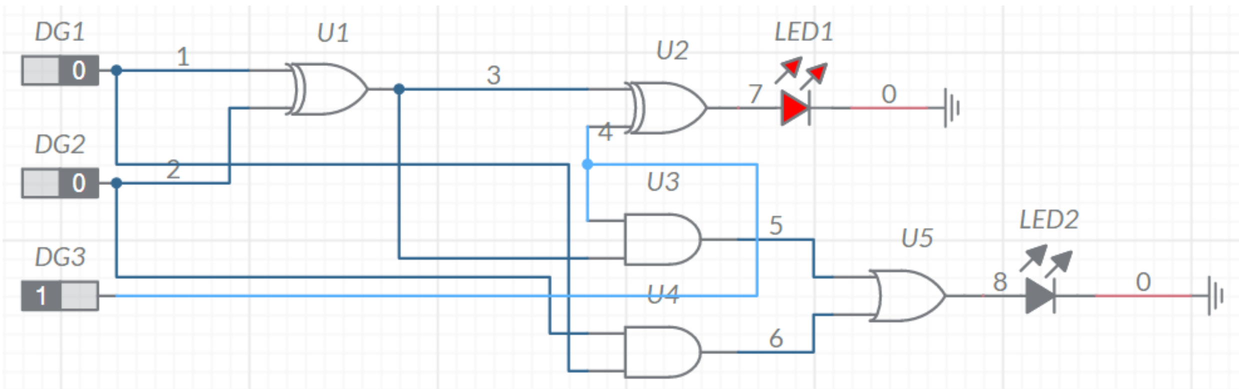


CIRCUIT OF:FULL ADDER

INPUTS			OUTPUTS	
A	B	C_{in}	SUM	$\text{CARRY}_{\text{OUT}}$
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

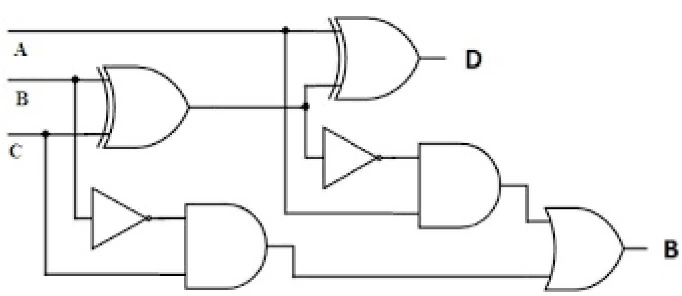


CIRCUIT OF:FULL ADDER USING NAND GATES



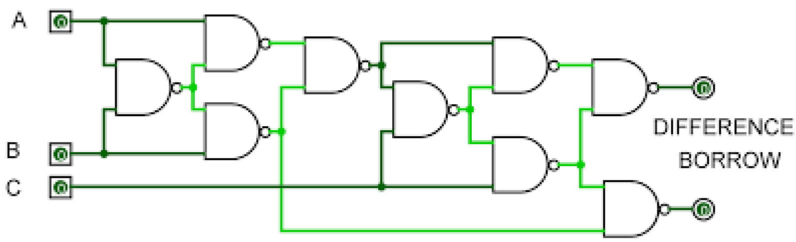
SIMULATION OF FULL ADDER

FULL SUBTRACTOR:

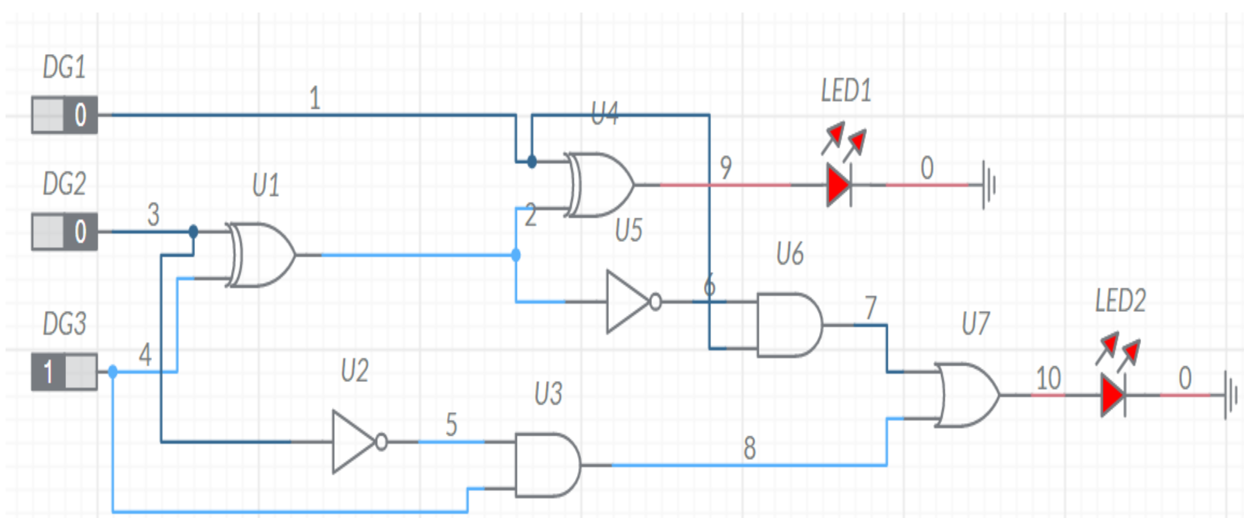


CIRCUIT OF:FULL SUBTRACTOR

Inputs			Outputs	
A	B	$Borrow_{in}$	Diff	Borrow
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



CIRCUIT OF:FULL SUBTRACTOR USING NAND GATES



SIMULATION OF FULL SUBTRACTOR

- <u>CONCLUSION:</u>

→ In the above experiment we learnt about, the fundamental gates (AND, OR and NOT) and the derived gates obtained by combining the fundamental gates for e.g. (NOR, NAND & EX-OR), we also learnt about their functionality and operations in Boolean Algebra.

→ A Half Adder is used to add 2 LSB. It can be designed by using EX-OR gate as sum and AND gate as carry or by using only NAND gates. It's equation for sum (S) = $\overline{A}.B + A\overline{B}$ and carry (C) = A.B.

→ A Half Subtractor can be made by EX-OR, AND and NOT gates or by using only NAND gates. It's equation for difference (D) is $\overline{A}\cdot B + A\cdot\overline{B}$ and borrow (B) = $\overline{A}B$

→ A Full Adder can be made using only NAND gates or EX-OR, AND and OR gates. It's equation for sum (S) = $\overline{A}\,\overline{B}C + \overline{A}\,B\overline{C} + A\overline{B}\,\overline{C} + ABC$ and carry (C) = AB + BC + AC.

→ A Full subtractor can be made using EX-OR, NOT, AND and OR gates or just by NAND gates. It's equation for difference and borrow is $D = \overline{A}\,\overline{B}C + \overline{A}B\overline{C} + A\overline{B}\,\overline{C} + ABC$ and $B = \overline{A}B + \overline{A}C + BC$