Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

3C2 DIGITAL CIRCUITS LABORATORY D1

Integer Comparison Circuit:

Department of Electronic and Electrical Engineering

(Multisim e-Report submission)

Submitted by :

Pardeep Singh

21355148

Introduction :

The circuit is used to make the interconnection which is intricate with electrical systems and has contacts that relay with switches. For this system the theory of logical gates is used, these comparators are basically of standard logic gates such as AND, OR,NAND,NOR,XOR,XNOR,XNAND and NOT. Along with that, the computing function has been represented with impact on the final circuits. The valid range of the circuits has also been used in mapping the representations along with the input and output voltages. The path has been propagated with a maximum level of transistor circuits along with the use of several logic elements and circuits which are connected to each other. The simulation has also been done to identify the parameters along with the maximum delay and minimum hold times of the circuits.

The main purpose of any comparator is to compare any set of known numbers and give a result depend on the condition. In case of integers there are many different ways for comparisons such as divide and conquer, binary distribution etc (these methods are usually for finding the largest number by comparing all the numbers)

There are many bit comparators that we can deal, which are

1-bit comparator,

2-bit comparator,

4-bit comparator,

8-bit comparator,

16-bit comparator and so more….

In this case I am going to deal with 2-bit comparator for my comparison circuit.

I will going to use the transistors on the places of basic logic gates. the main aim is to use transistors in the place of gates to built our 2 bit comparator circuit. I am going to connect the transistor to transistor in the format of logic gates. By doing so I am trying to build a transistor-transistor logic circuit, and implement it for the comparator circuit and on using this logic it will maintain the logic states and achieve switches with transistors.

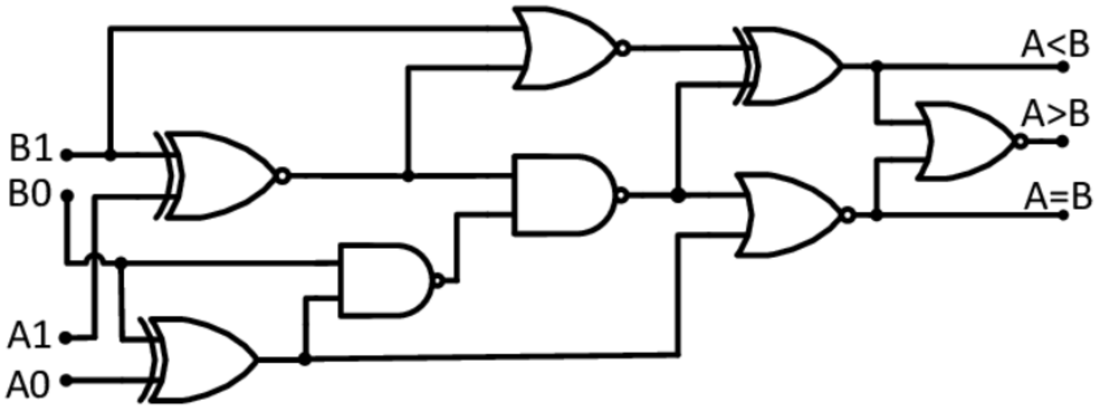
The main features of transistor-transistor logic are listed below.

Implementation

Here I am going to implement an integer comparison circuit, which is basically give true value for A<B, A>B and A=B otherwise it is false,

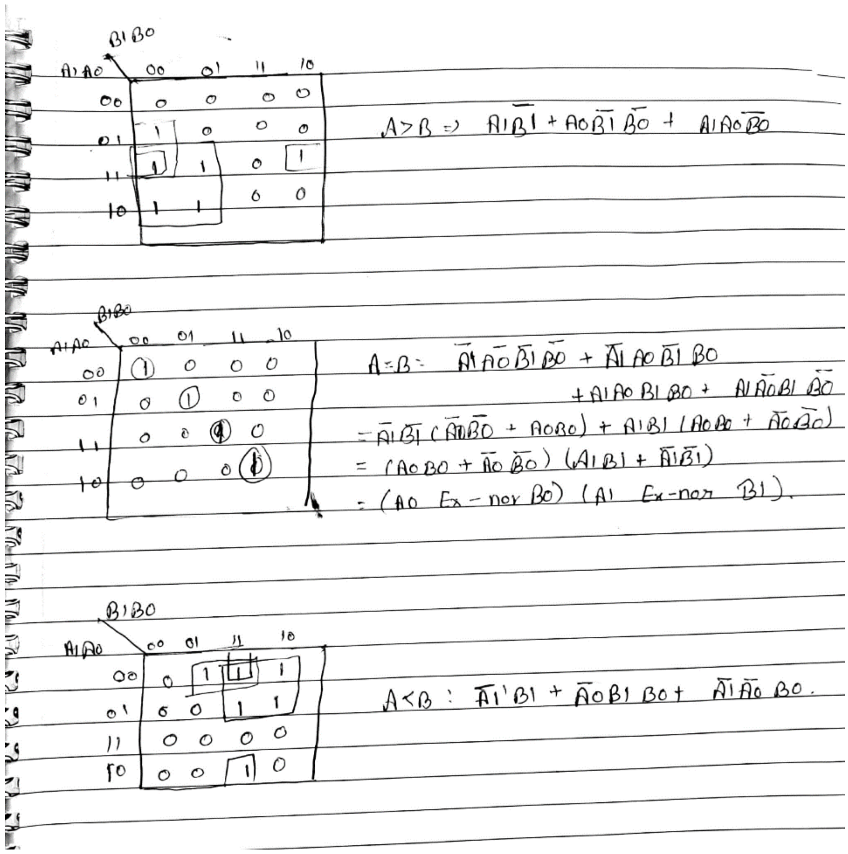
This structure contains mainly XOR, XNOR,NOR and NAND gate., 4 inputs and 3 outputs which would give the output of comparators A<B, A>B and A=B

Structure ->



2-bit comparator circuit using logic gates

Given below is the k map and the equations for the 2-bit comparator



The basic truth table for a 2-bit comparator circuit is given below

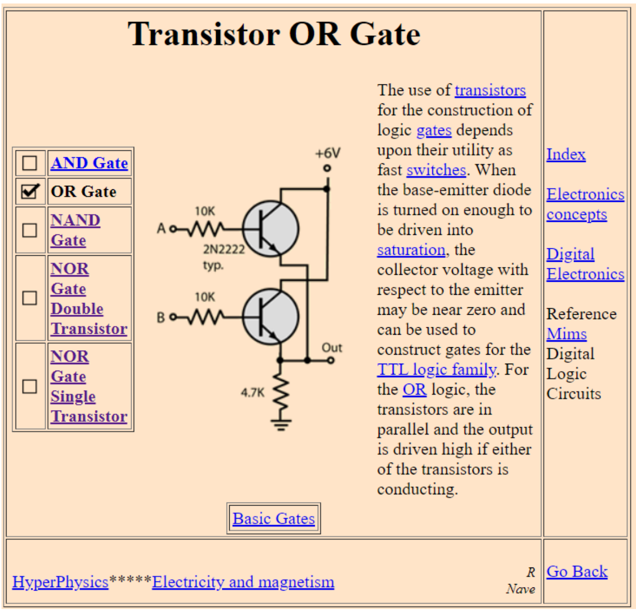
INPUT				OUTPUT		
A1	A0	B1	B0	A<B	A=B	A>B
0	0	0	0	0	1	0
0	0	0	1	1	0	0
0	0	1	0	1	0	0
0	0	1	1	1	0	0
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	1	0	0
0	1	1	1	1	0	0
1	0	0	0	0	0	1
1	0	0	1	0	0	1
1	0	1	0	0	1	0
1	0	1	1	1	0	0
1	1	0	0	0	0	1
1	1	0	1	0	0	1
1	1	1	0	0	0	1
1	1	1	1	0	1	0

Truth table for 2-bit comparator

Basically, I am replacing all the logical gates with the transistors(Transistor-Transistor logic). This depends upon their utilities as fast they switches. I use NPN type transistors for the implementation , Below are the major transistor gates I used in comparison circuit

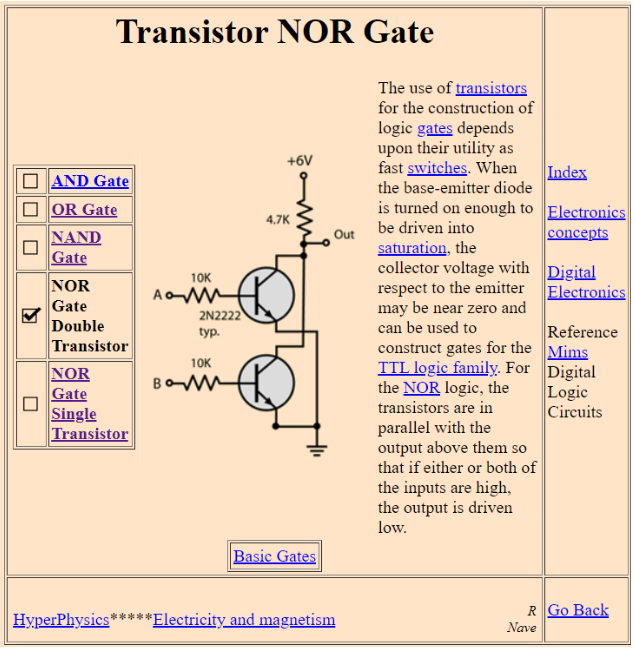
OR gate circuit as a transistor

In or gate circuit there are two transistors, which are connected in parallel base of both the transistor is connected with the input source, it works like if any of the transistor allow the floew of current then current will flow and ,it is blocked when both the inputs are low,



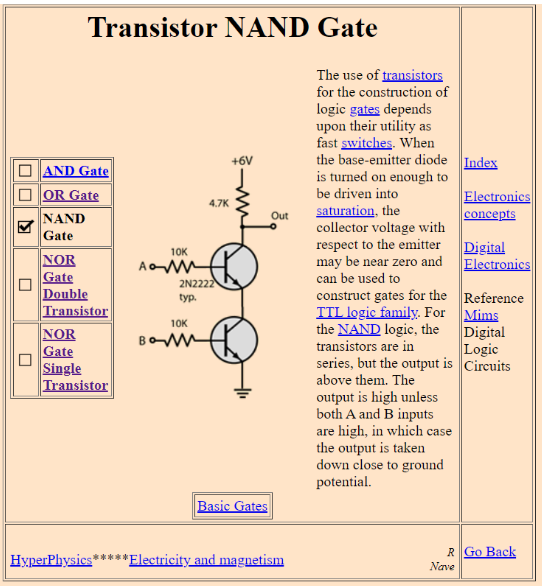
NOR gate circuit as a transistor

In or gate circuit there are two transistors, which are connected in parallel base of both the transistor is connected with the input source, it works like if any of the transistor allow the floew of current then current will flow and ,it is blocked when both the inputs are low, all the the transistors are connected same way as OR gate, but the output is like as Not gate



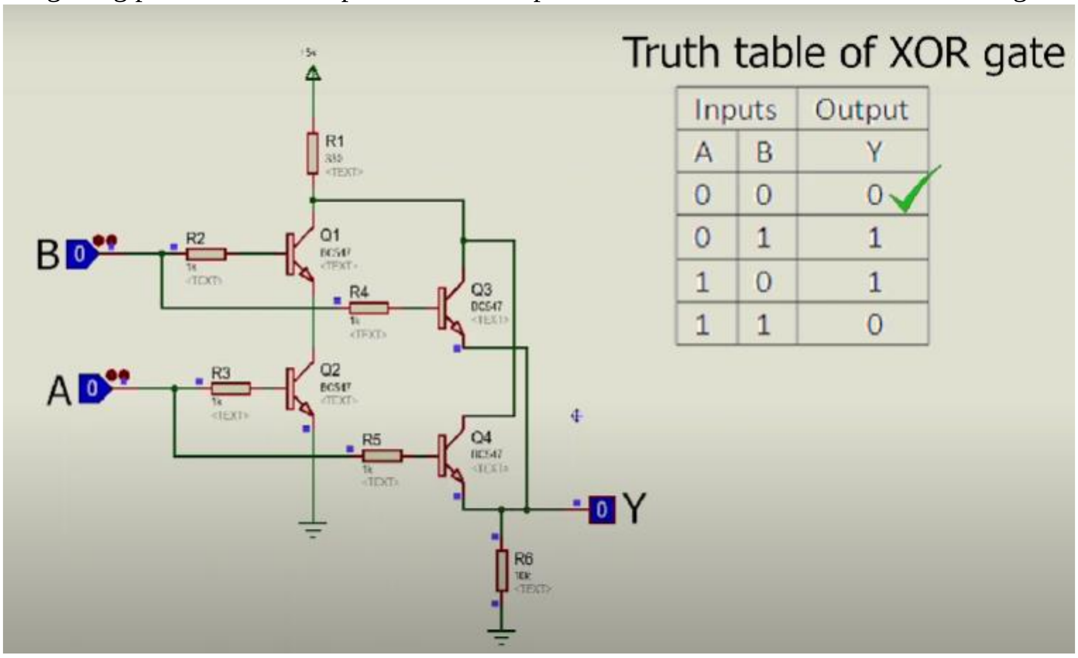
NOR gate circuit as a transistor

In AND gate transistors are connected in series and base of both the transistor is connected with input sources . it block the current if any of the one inpt is low, the cue=rrent will only flow when both the inouts are high, NAND gate is same as the AND transistor gate but output is same as the NOT gate because Output is connected with a source volt instead of ground



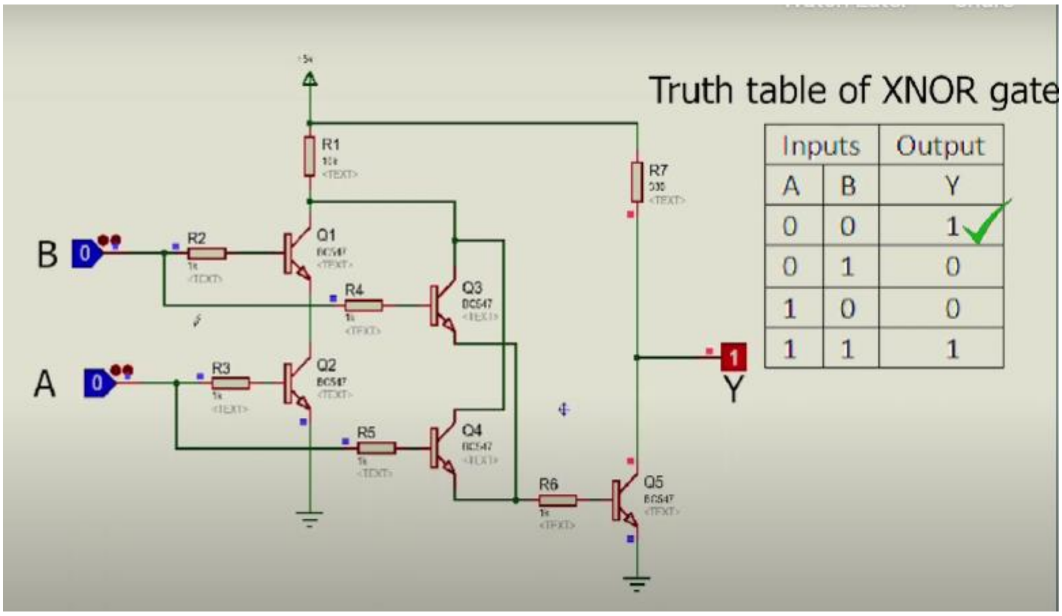
XOR gate circuit using transistor

XOr is a little bit complicate circuit in case of transistor , there are 4 transistors are used with the pais of 2-2. One pair of 2 transistors is connecte like AND (a, b) gate transistor Circuit and another pair of transistor is connected like OR gate(c,d), the working is like when both inputs are high transistor a and b allows the current to pass and and it block the current when both the inputs are low. So c and d are getting powered. The output of both the cpombination results as an outout of XOr gate



XNOR gate circuit using transistor

XNOR circuit_ is almost same as the xor gate, ton converting the output into a xnor gate a another transistor is used, this is used to get rid of the _,1,1 condition_which isd getting voilated because of both high inputs.

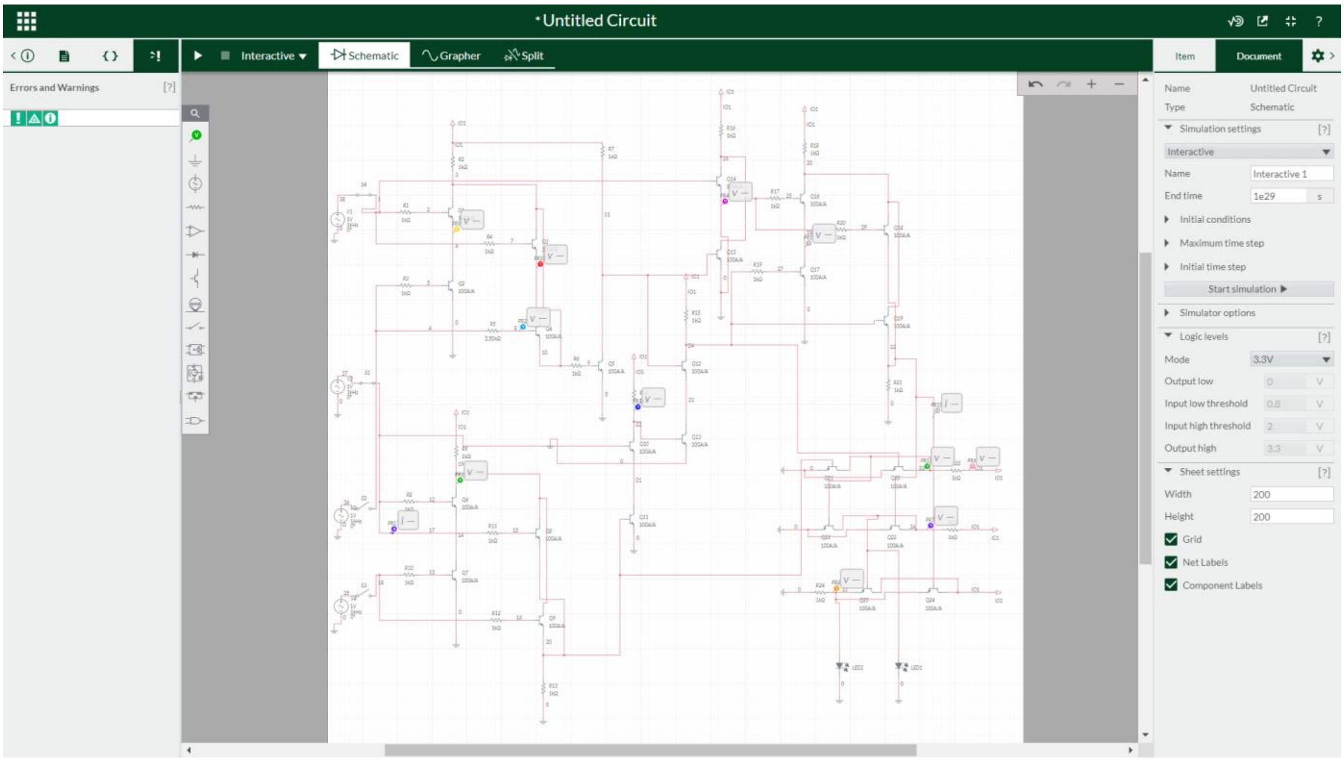


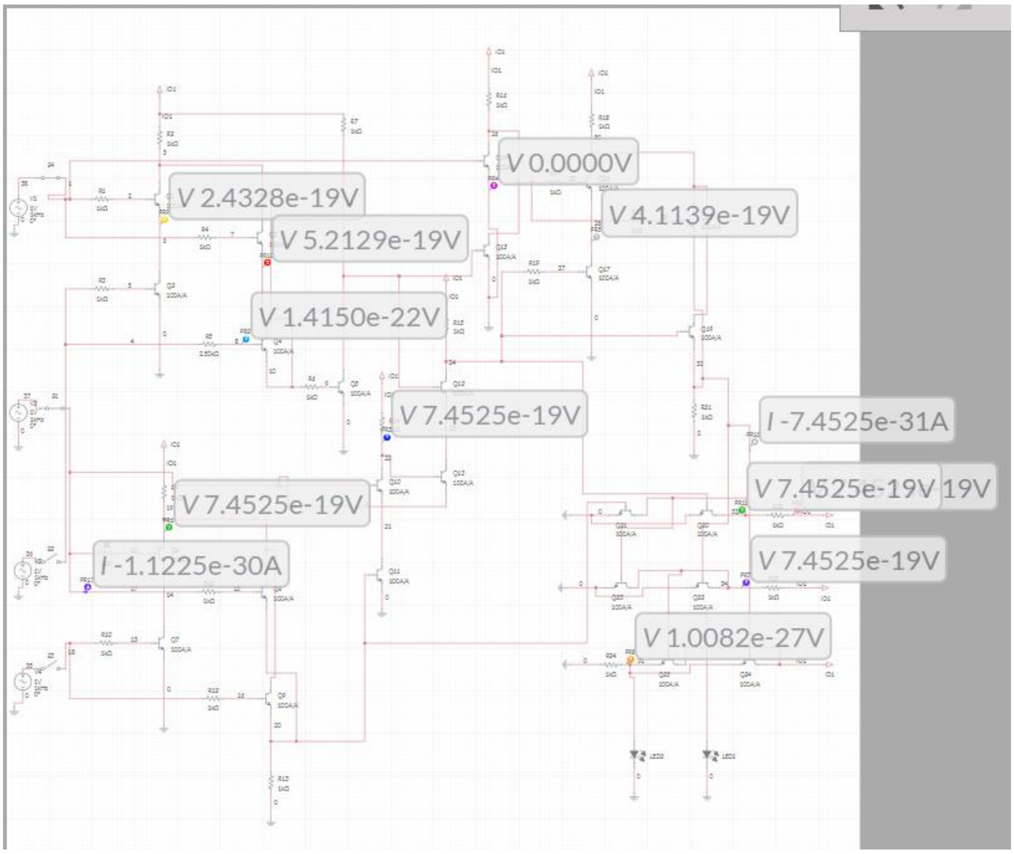
For the implementation I am using AC voltage of 1A and 1khz frequency at 0°C with switches , resistance of 1kohmleds and 24 transistors.

For getting the the less then equal to value I am using or gate in front of A<B and A=B output.

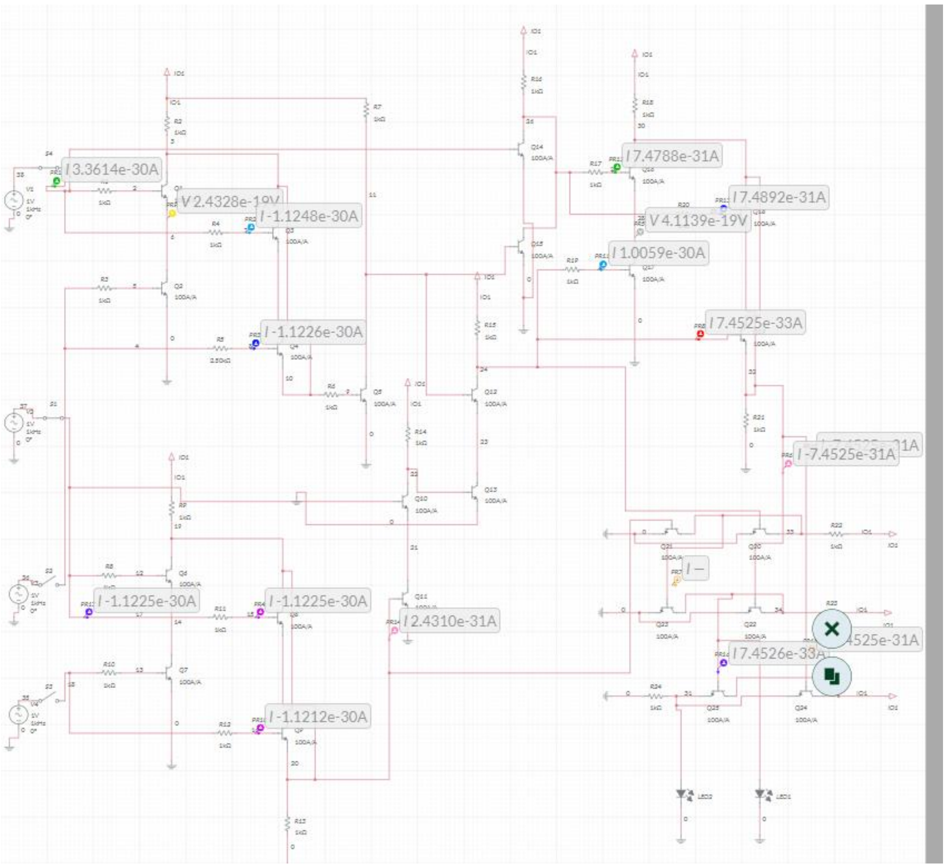
<u>Schematic :</u>

We use Multisim software for the implementation purpose



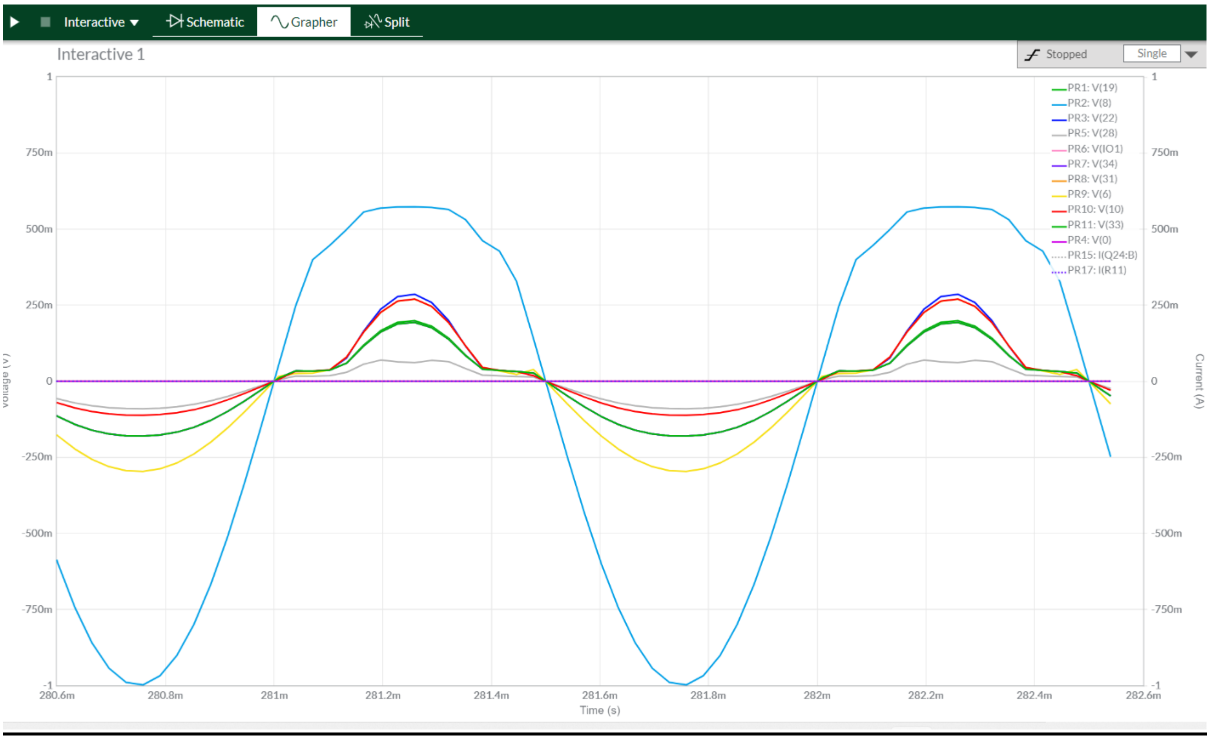


V 0.0000V
V 2.4328e-19V
V 4.1139e-19V
V 5.2129e-19V
V 1.4150e-22V
V 7.4525e-19V
I -7.4525e-31A
V 7.4525e-19V
V 7.4525e-19V
I -1.1225e-30A
V 7.4525e-19V
V 1.0082e-27V



I 3.3614e-30A
I 7.4788e-31A
I 7.4892e-31A
I -1.1248e-30A
V 4.1139e-19V
I 1.0059e-30A
I -1.1226e-30A
I 7.4525e-33A
I -7.4525e-31A
I -1.1225e-30A
I -1.1225e-30A
I 2.4310e-31A
I 7.4526e-33A
I -1.1212e-30A

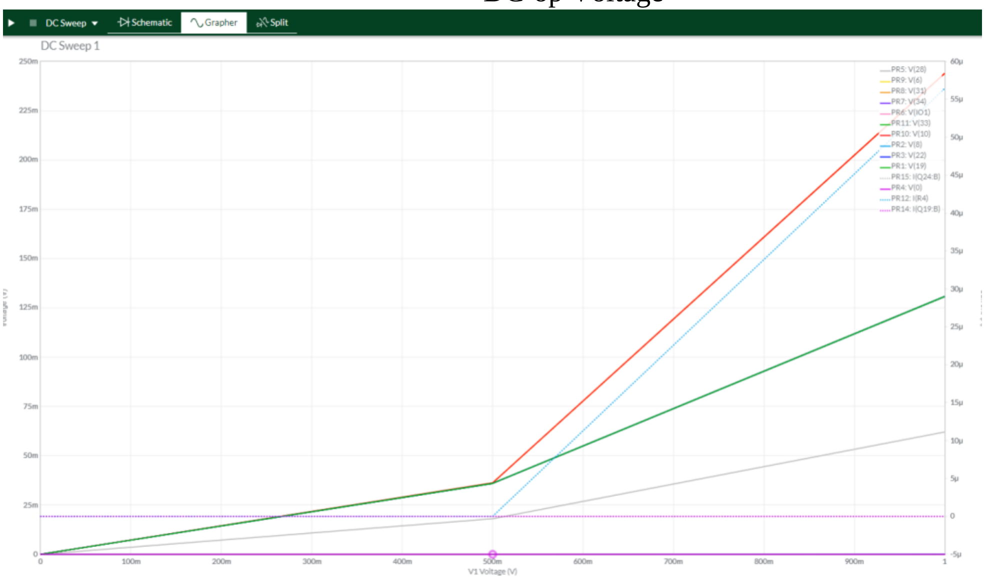
Test and graphs



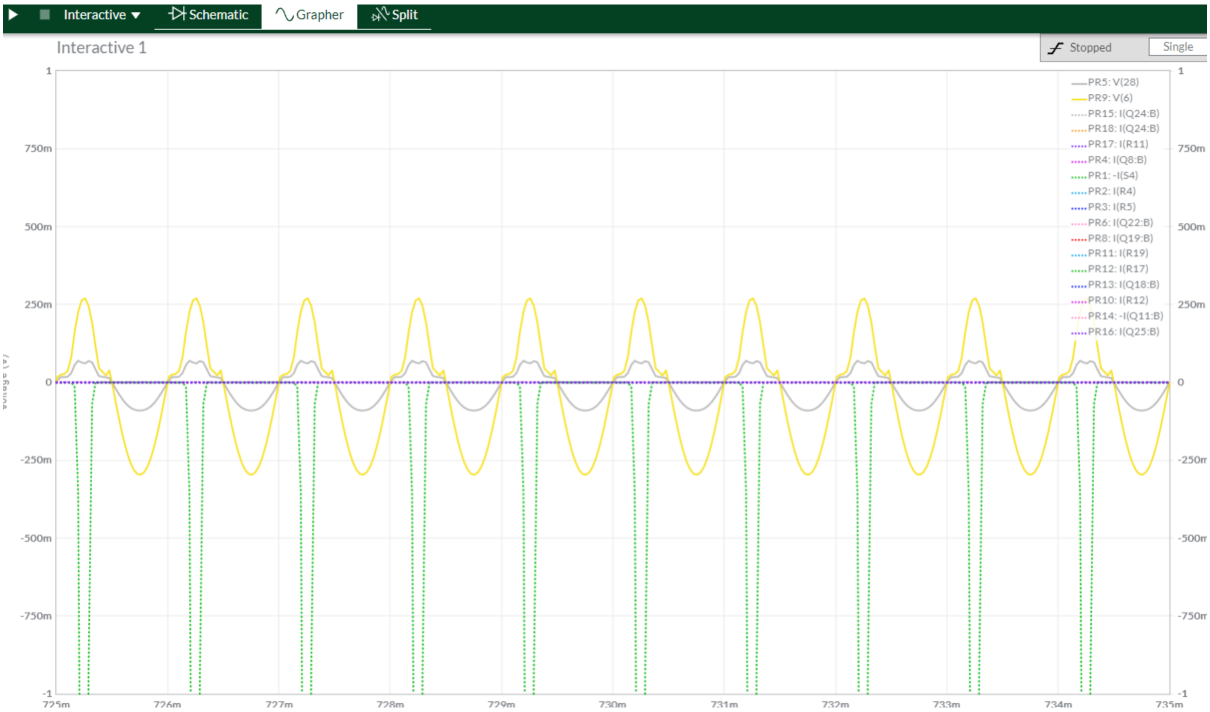
Voltage

Signal	Value
PR1: V(19)	7.4525e-19V
PR2: V(8)	1.4150e-22V
PR3: V(22)	7.4525e-19V
PR5: V(28)	4.1139e-19V
PR6: V(IO1)	7.4525e-19V
PR7: V(34)	7.4525e-19V
PR8: V(31)	1.0082e-27V
PR9: V(6)	2.4328e-19V
PR10: V(10)	5.2129e-19V
PR11: V(33)	7.4525e-19V
PR4: V(0)	0.0000V
PR15: I(Q24:B)	-7.4525e-31A
PR17: I(R11)	-1.1225e-30A

DC-op Voltage



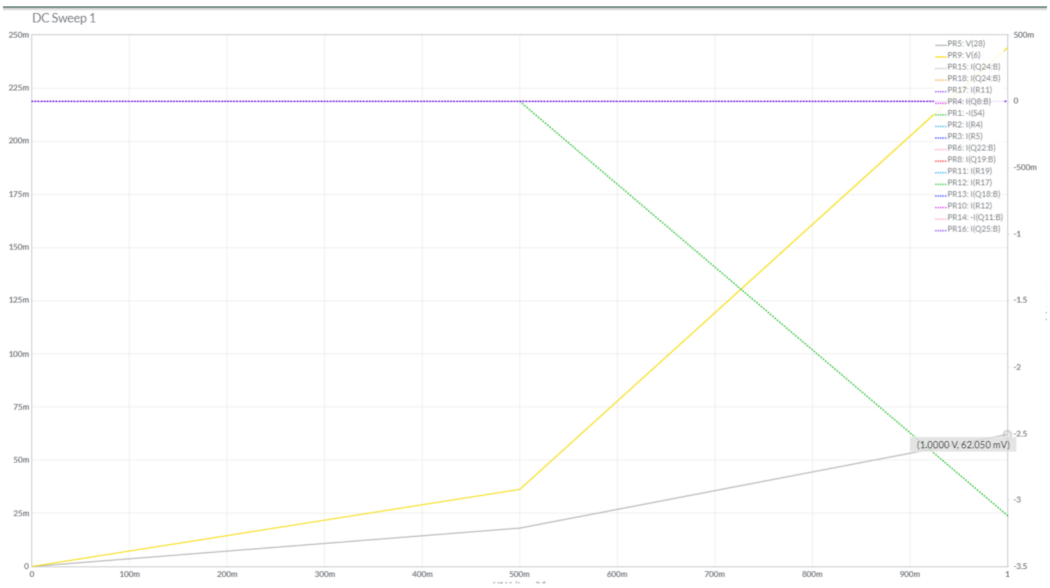
DC-sweep(Voltage)



Current

Signal	Value
PR5: V(28)	4.1139e-19V
PR9: V(6)	2.4328e-19V
PR15: I(Q24:B)	-7.4525e-31A
PR18: I(Q24:B)	-7.4525e-31A
PR17: I(R11)	-1.1225e-30A
PR4: I(Q8:B)	-1.1225e-30A
PR1: -I(S4)	3.3614e-30A
PR2: I(R4)	-1.1248e-30A
PR3: I(R5)	-1.1226e-30A
PR6: I(Q22:B)	-7.4525e-31A
PR8: I(Q19:B)	7.4525e-33A
PR11: I(R19)	1.0059e-30A
PR12: I(R17)	7.4788e-31A
PR13: I(Q18:B)	7.4892e-31A
PR10: I(R12)	-1.1212e-30A
PR14: -I(Q11:B)	2.4310e-31A
PR16: I(Q25:B)	7.4526e-33A

DC-op Current



DC-sweep circuit(current)

Importance of TTL

Some important advantages of using Transistor-transistor logic circuits.

- The uses of transistor logics avoid the problem of reduced noise margin, increases switching resistance and increase static power dissipation
- Transistor logic uses much less power as compared to logic gate
- As transistors can turn ON and off much faster hence switch time became more faster
- The require voltage is 3V to 16V and VSS is ground
- Transistor-transistor logic has strong drive capability.

Conclusion

This design is based on the comparison circuit ,to make a one we are using transistors instead of logic gates, transistors are always a basic building blocks of a computer hardware, use of transistors on the place of logic gates result in advantages, like increase the speed, consume less power etc. so I created a comparison circuit by replacing the logic gates by transistors and use an ac voltage source to check the testing and verifications of the my logic, all the inputs and outputs are given above in the graph section. However I am not able to verify the full truth table getting some missed values at some particular stages.

As I am using ac voltage so the output is blinking as there is always an variation of same amplitude in ac source.

Using of transistor in alu is very effective as compared other methods , even it become possible to use parsing, compiling over the alu if it is made of transistors and it become immensely powerful.

As the size of transistor is became small and small and the results become more powerful, their capability of amplify current and voltages helps to diverse application, with many of advantages of using transistor on the places logic gates and other operators improves the output

SO until this point the most widely recognized utilization of transistors today is for PC memory chips-including strong state media capacity gadgets for electronic games, cameras, and MP3 players-and microchips, where a large number of parts are inserted in a solitary coordinated circuit.

References:

1. https://en.wikipedia.org/wiki/Logic_optimization
2. https://www.quora.com/?pa_story=NjcxNjA2NDA5MTk3MzI2MjcyfDIxMTEwNjIzNjAzODE0MXww
3. https://www.quora.com/I-understand-how-transistors-perform-alu-operations-but-how-do-transistors-approach-other-non-alu-tasks-like-compiling-parsing-etc-To-me-transitors-can-only-tackle-alu-problems
4. https://www.britannica.com/technology/transistor
5. https://www.tutorialspoint.com/linear_integrated_circuits_applications/linear_integrated_circuits_applications_comparators.htm
6. https://en.wikipedia.org/wiki/Comparator#:~:text=A%20comparator%20circuit%20compares%20two,has%20reached%20some%20predetermined%20value.
7. http://ggn.dronacharya.info/ITDept/Downloads/QuestionBank/Odd/III%20sem/Section-B/digital-electronics_3.pdf
8. https://en.wikipedia.org/wiki/Comparator#:~:text=A%20comparator%20circuit%20compares%20two,has%20reached%20some%20predetermined%20value.
9. https://en.wikipedia.org/wiki/Transistor%E2%80%93transistor_logic#History
10. https://www.electrical4u.com/digital-comparator/
11. https://studytronics.weebly.com/comparators.html
12. https://www.techtarget.com/whatis/definition/transistor-to-transistor-logic-TTL
13. https://www.techopedia.com/definition/3057/transistor-transistor-logic-ttl