Circuit Simulation Project

https://esim.fossee.in/circuit-simulation-project

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Project Guide: Dr R. Maheshwari

Title: Design of Single-bit Magnitude Comparator

Theory:

Magnitude comparators are mostly utilized in microcontrollers and CPUs to address data comparison, register and perform other arithmetic operations. They are also implemented in many devices and every auto-turn-off device is designed using a comparator only.

A comparator is a decision-making tool and it holds the ability to be executed in numerous control devices. Accepting two binary numbers as input (A and B), data comparison through magnitude comparators produces the output to indicate the relationship whether less than, equal to and greater than between those two binary numbers (i.e., A<B, A=B, A>B)

There are different types of comparators using digital logic gates. A comparator used to compare two bits is called a single bit comparator. It consists of two inputs each for two single bit numbers and three outputs.

The truth table for 1-bit comparator is as follows:

A	B	A<B	A=B	A>B
0	0	0	1	0
0	1	1	0	0
1	0	0	0	1
1	1	0	1	0

For A<B, there is only one case when the output is high when A=0 and B=1. We can write the equation as follows:

A<B = A'B

For A>B, there is only one case when the output is high when A=1 and B=0. We can write the equation as follows:

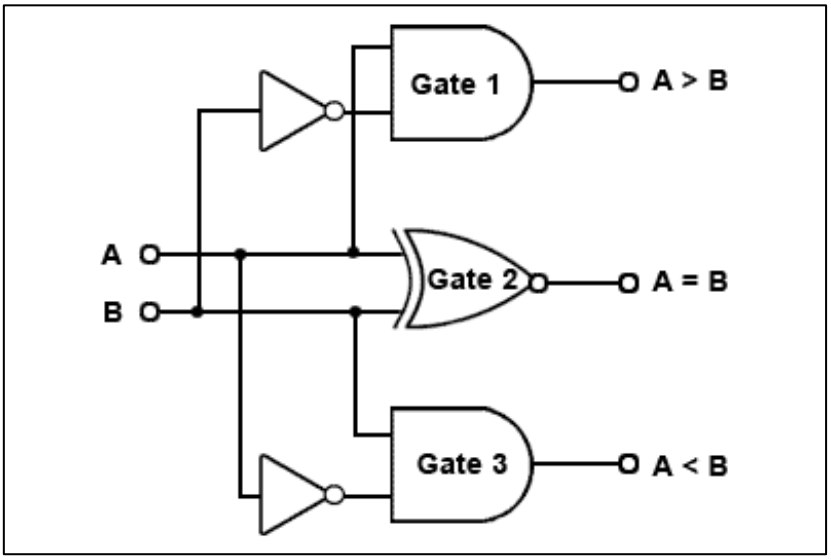
A>B = AB'

This is because the logic behind an OR gate is that a high output can be achieved in one or more cases. Z is high when A=0 and B=0, it is also high when A=1 and B=1. Therefore, Z = A'B' + AB

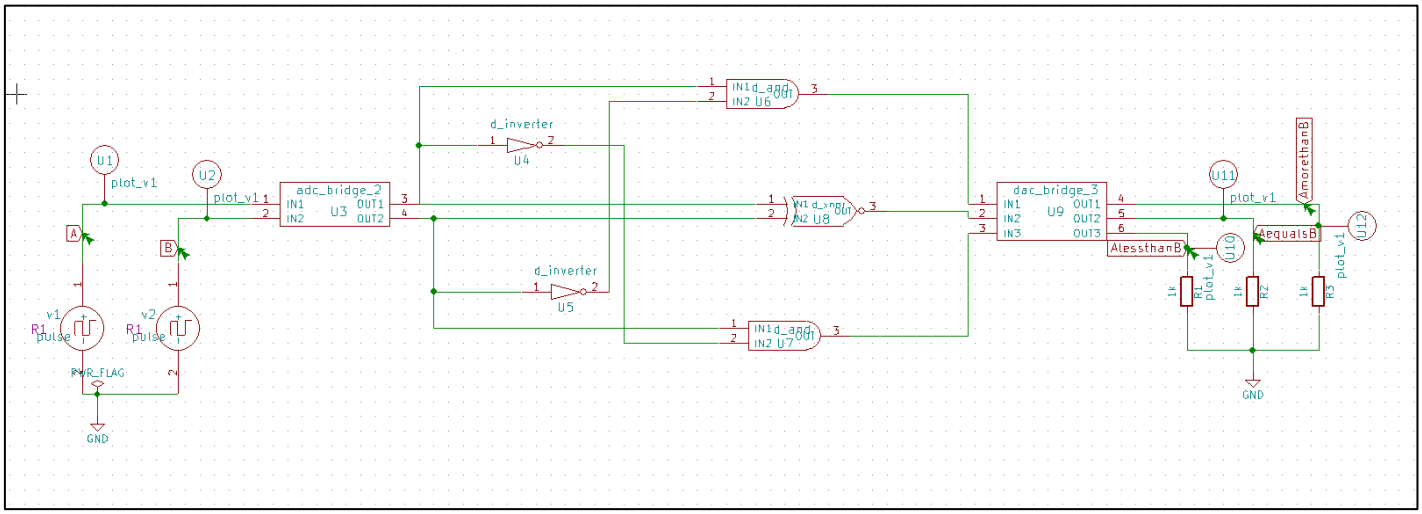
This is similar to the equation of an EXNOR gate. Hence,

Z = A XNOR B

Circuit diagram:

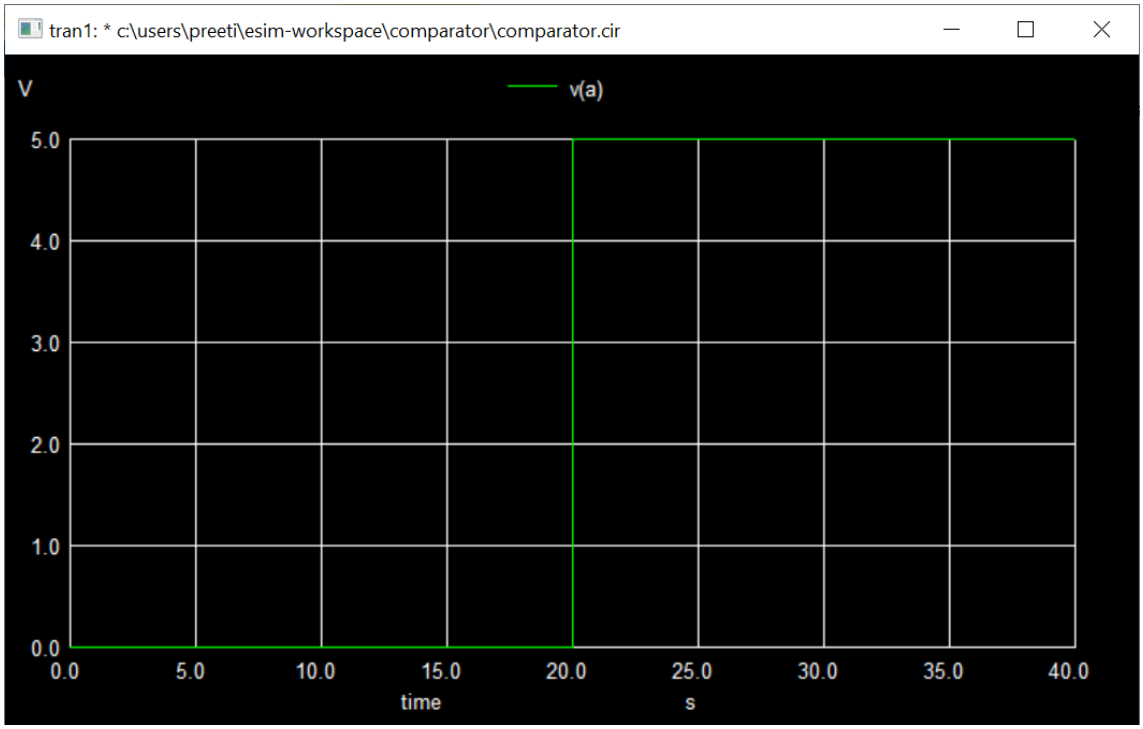


Schematic diagram:

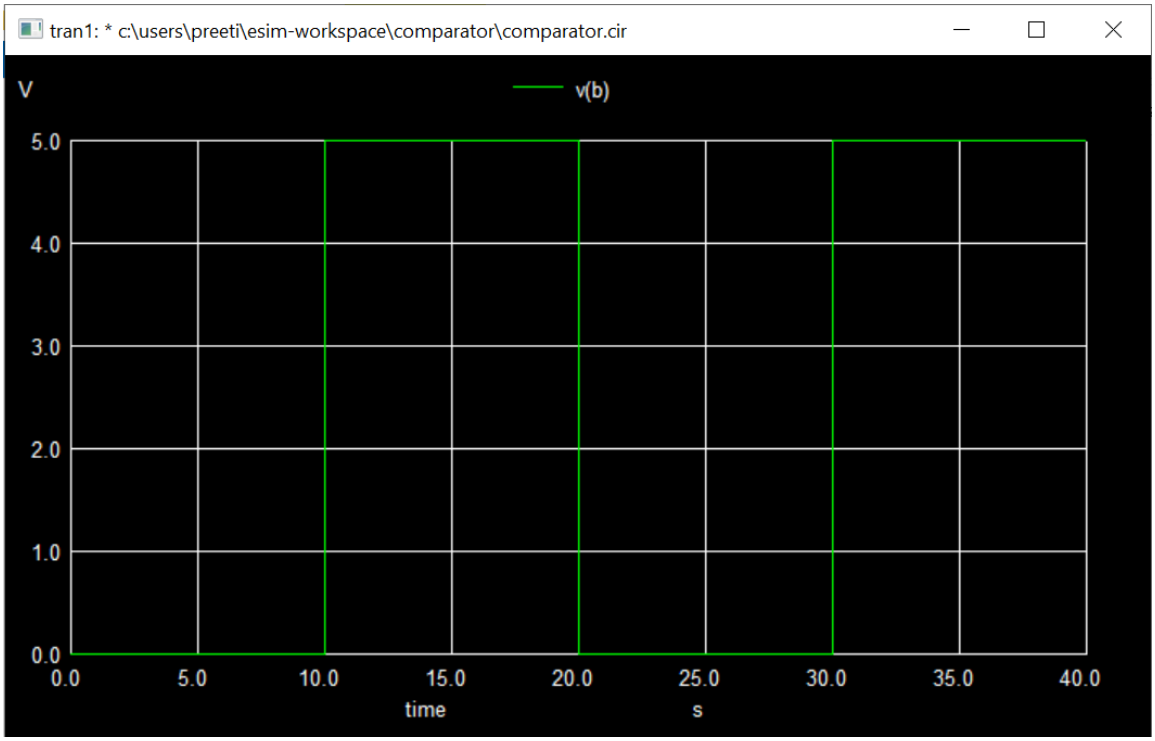


Plots:

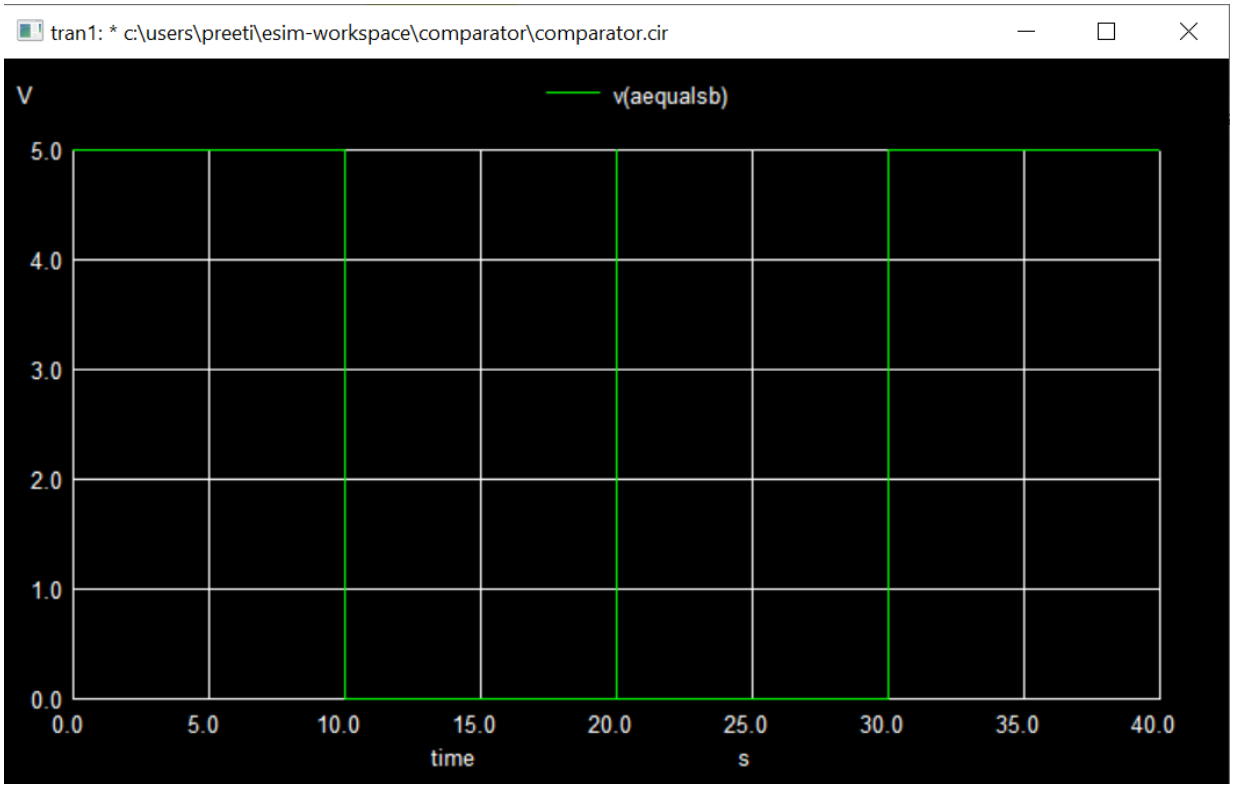
A:



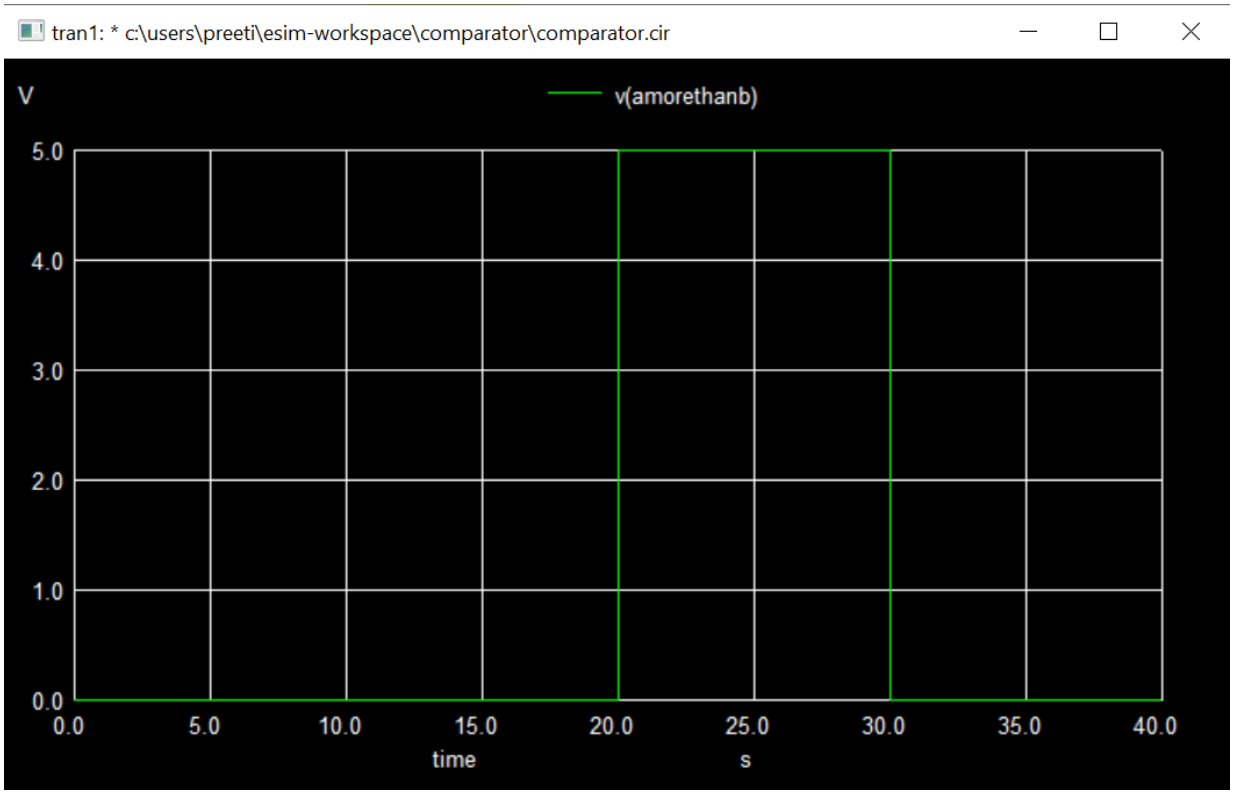
B:


tran1: * c:\users\preeti\esim-workspace\comparator\comparator.cir
V
v(b)
5.0
4.0
3.0
2.0
1.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
time
s

A=B:


tran1: * c:\users\preeti\esim-workspace\comparator\comparator.cir
V
v(aequalsb)
5.0
4.0
3.0
2.0
1.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
time
s

A>B: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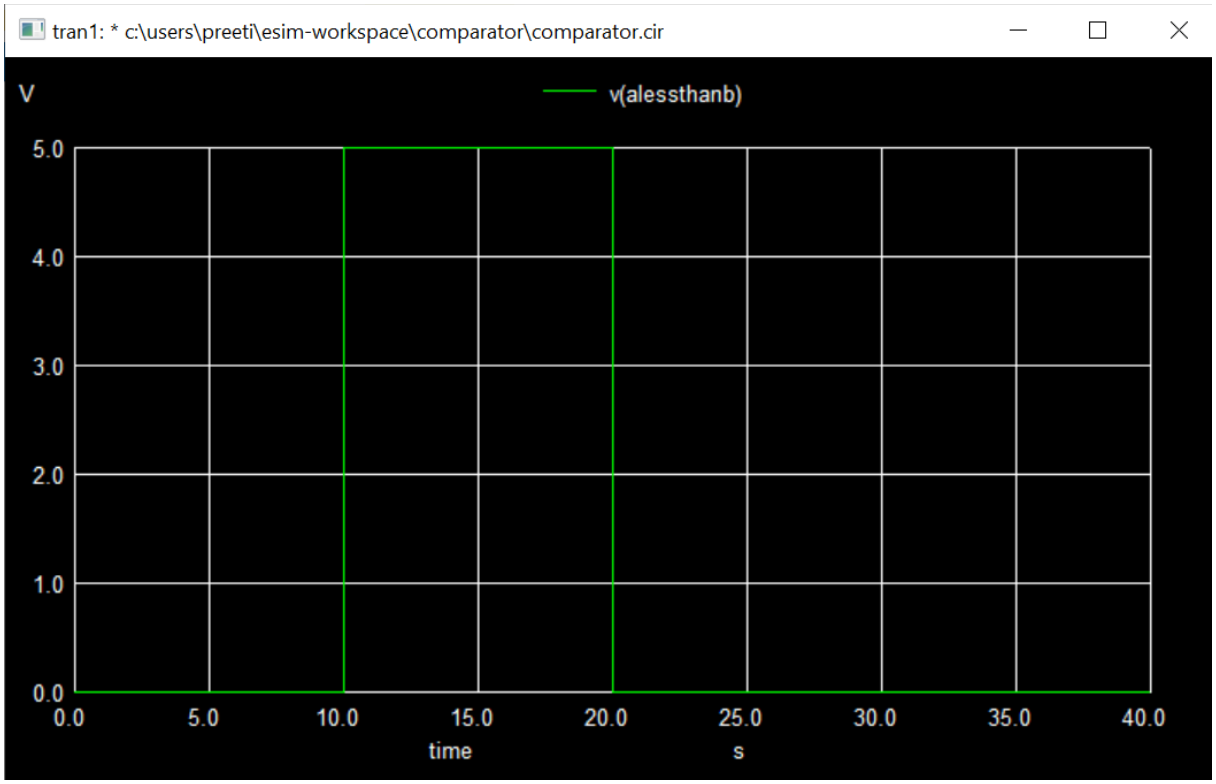
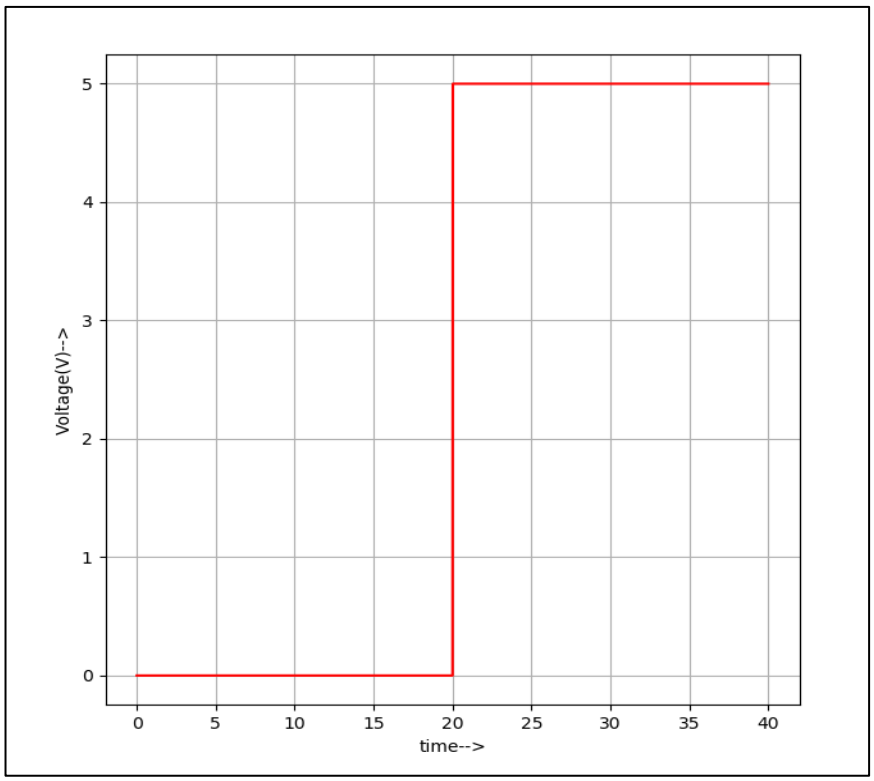
V
v(amorethanb)
5.0
4.0
3.0
2.0
1.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
time
s

A<B:

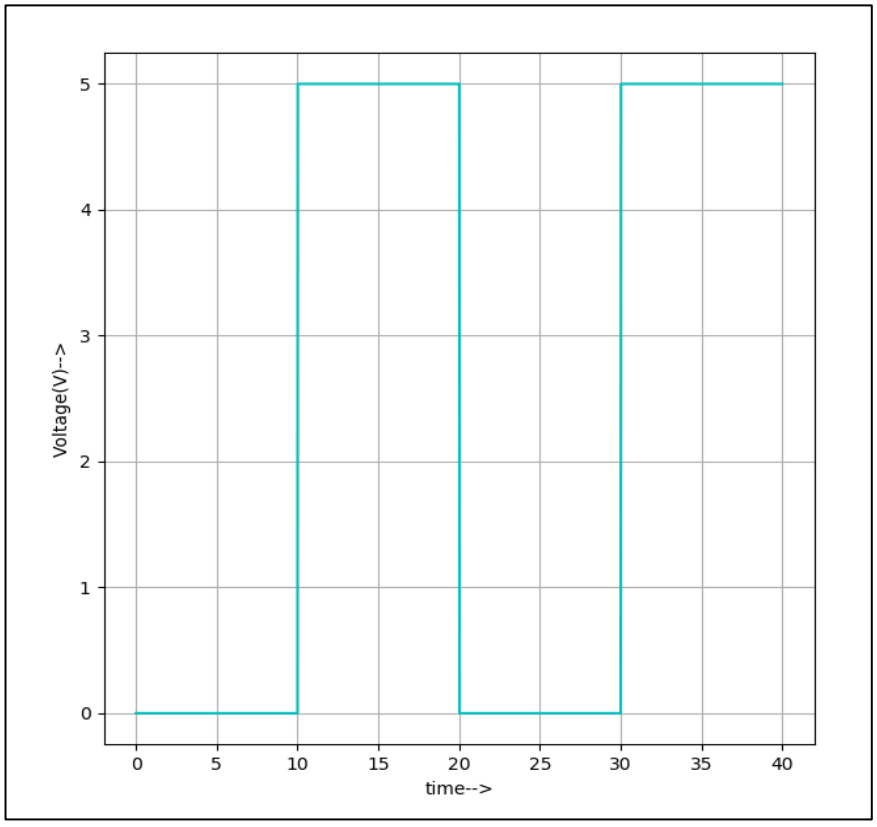

tran1: * c:\users\preeti\esim-workspace\comparator\comparator.cir
V
v(alessthanb)
5.0
4.0
3.0
2.0
1.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
time
s

Python Plots:

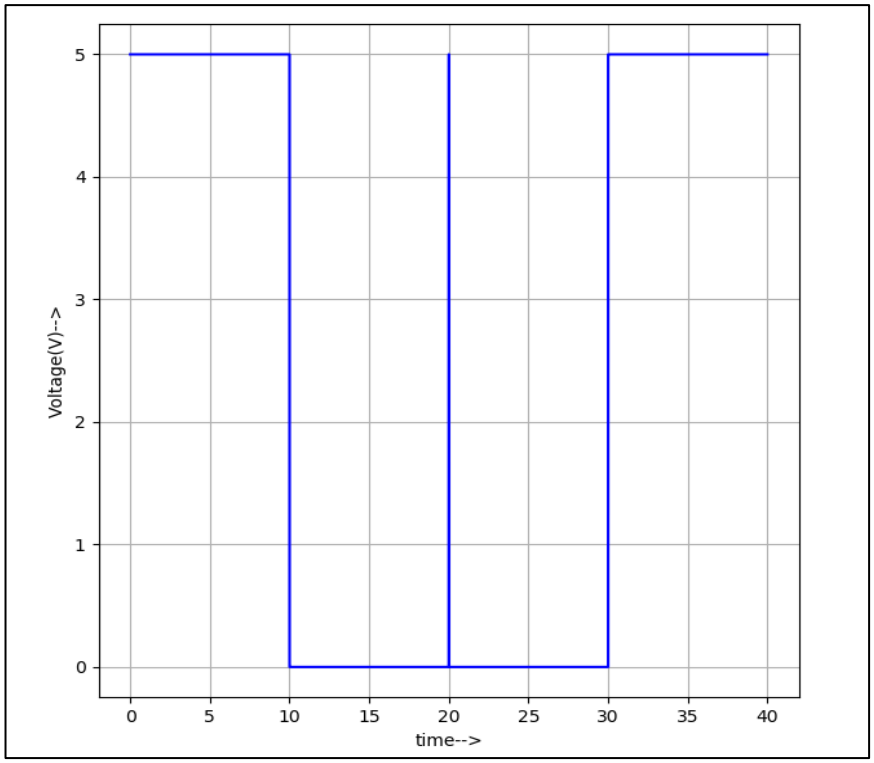
A:



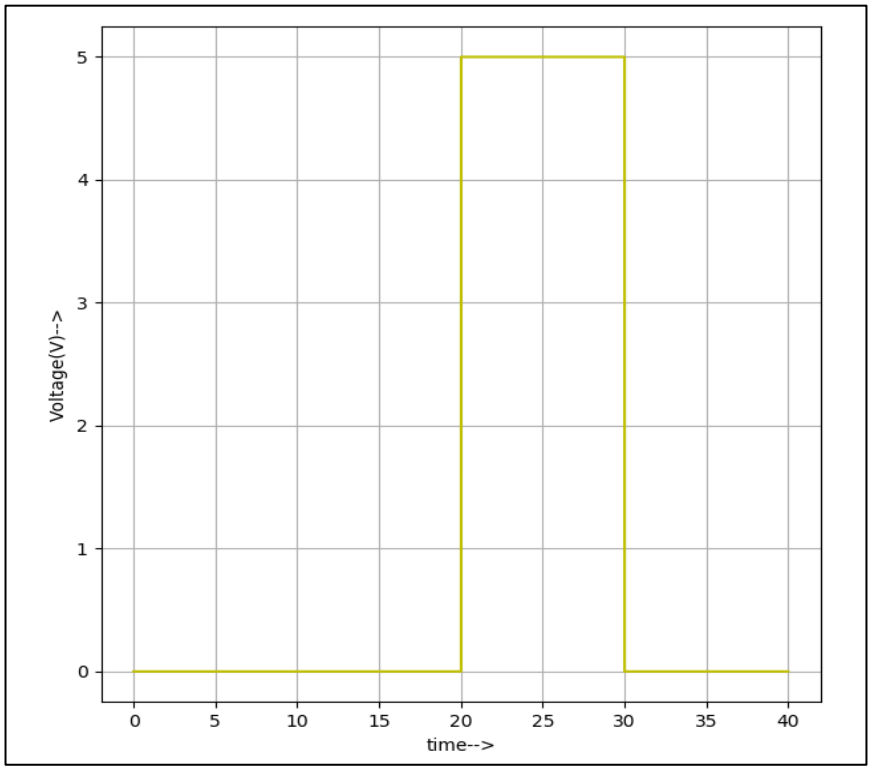
B:



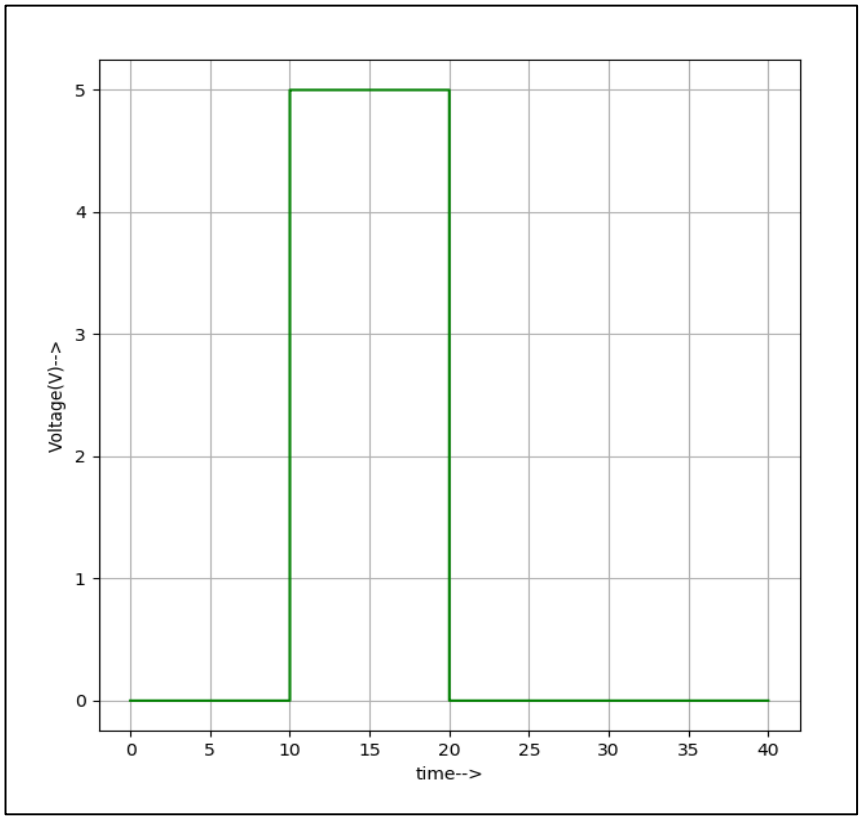
A=B:


Voltage(V)-->
time-->
0
1
2
3
4
5
0
5
10
15
20
25
30
35
40

A>B:


Voltage(V)-->
time-->
0
1
2
3
4
5
0
5
10
15
20
25
30
35
40

A<B



Conclusion:

Hence, single-bit magnitude comparator was designed and resulting plots were verified on Esim.

References:

1. https://www.geeksforgeeks.org/magnitude-comparator-in-digital-logic/
2. https://technobyte.org/2-bit-4-bit-comparator/
3. https://www.elprocus.com/digital-comparator-and-magnitude-comparator/