Circuit Simulation Project

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

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Project Guide: Dr. MAHESWARI. R

Title of the Project: -

Design of Full Subtractor using Nand gates

Theory/Description: -

Full subtractor is a combinational circuit which is used to perform two binary digits subtraction. Full subtractors can be used for different microcontrollers for arithmetic subtraction, timers and the program counter. These are used in processors to compute tables, addresses and also useful for Digital Signal Processing and networking based systems.

Full subtractor has three inputs namely A, B, Bin and two outputs namely Diff, Borrow. Here, the inputs indicate minuend, subtrahend and previous borrow for A, B and Bin respectively whereas the two outputs are denotes difference and borrow output for Diff and Borrow.

Full subtractor can be designed using basic logic gates like OR, AND, XOR. This circuit can also be done designed by using only universal logic gates like using only NAND gates or only NOR gates.

Expressions for outputs in full sutractor:

Diff = A'B'Bin + A'BBin' + AB'Bin' + ABBin

   = Bin(A'B' + AB) + Bin'(AB' + A'B)

   = Bin(A XNOR B) + Bin'(A XOR B)

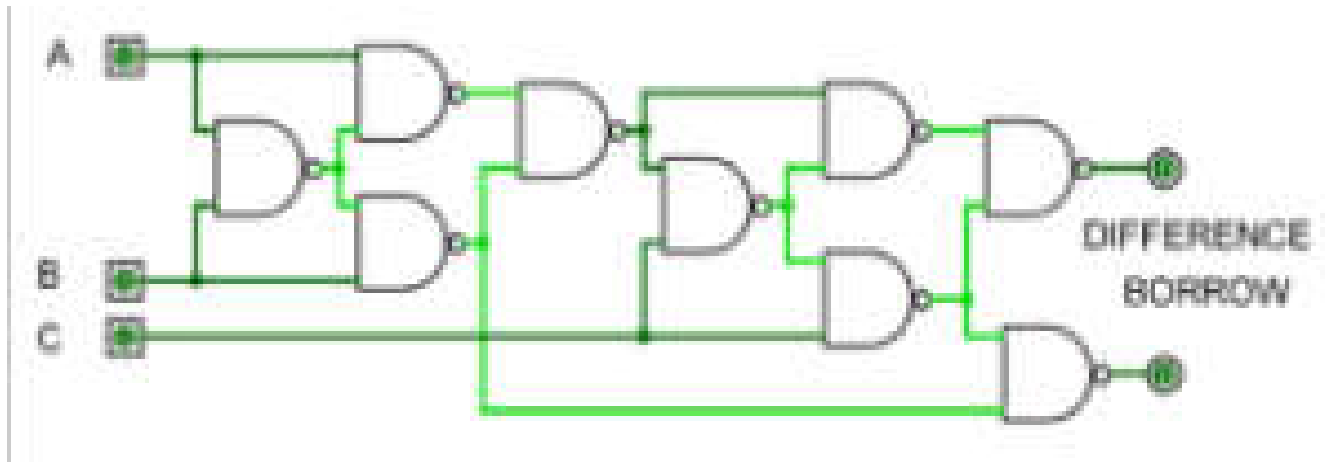   = Bin (A XOR B)' + Bin'(A XOR B)

   = Bin XOR (A XOR B)

   = (A XOR B) XOR Bin

Borrow = A'B'Bin + A'BBin' + A'BBin + ABBin

      = A'B'Bin +A'BBin' + A'BBin + A'BBin + A'BBin + ABBin

      = A'Bin(B + B') + A'B(Bin + Bin') + BBin(A + A')

      = A'Bin + A'B + BBin

Truth Table for Full subtractor circuit:

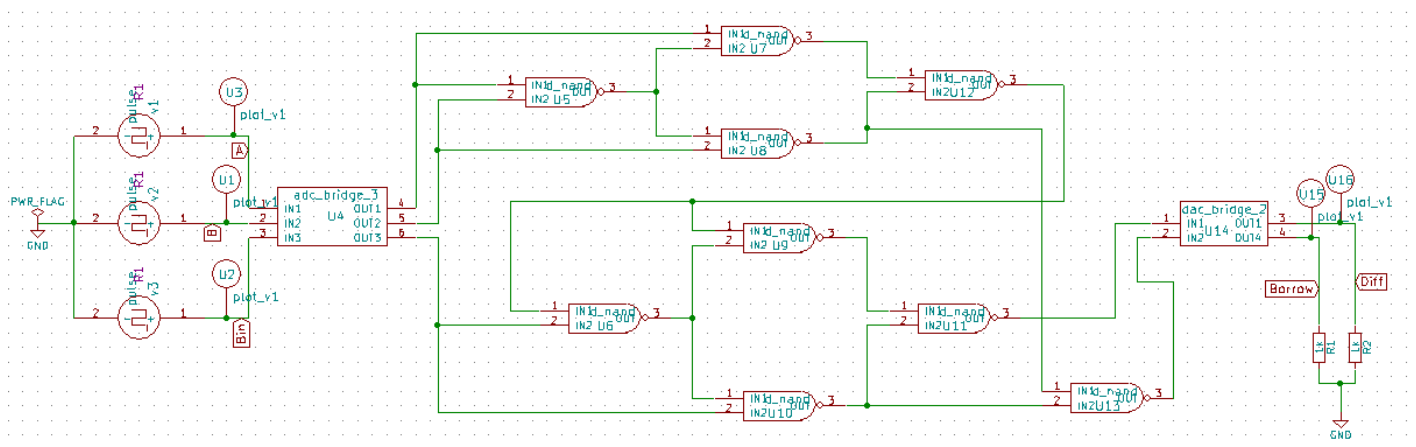| A	B	Bin	Diff	Borrow
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Here, A, B, Bin are inputs and Diff, Borrow are outputs.

Circuit for Full Subtractor using Nand gates:

Schematic Diagram:

The circuit schematic for Full Subtractor using Nand gates in eSim is as shown below:

Source details:

Analysis | Source Details | NgSpice Model | Device Modeling | Subcircuits

Add parameters for pulse source v1

Enter initial value(Volts/Amps):	0
Enter pulsed value(Volts/Amps):	5
Enter delay time (seconds):	20
Enter rise time (seconds):	0
Enter fall time (seconds):	0
Enter pulse width (seconds):	20
Enter period (seconds):	40

Analysis | Source Details | NgSpice Model | Device Modeling | Subcircuits

Add parameters for pulse source v2

Enter initial value(Volts/Amps):	0
Enter pulsed value(Volts/Amps):	5
Enter delay time (seconds):	10
Enter rise time (seconds):	0
Enter fall time (seconds):	0
Enter pulse width (seconds):	10
Enter period (seconds):	20

Add parameters for pulse source v3

Enter initial value(Volts/Amps):	0
Enter pulsed value(Volts/Amps):	5
Enter delay time (seconds):	5
Enter rise time (seconds):	0
Enter fall time (seconds):	0
Enter pulse width (seconds):	5
Enter period (seconds):	10

Analysis:

Transient Analysis

Start Time	0	Sec
Step Time	10	ms
Stop Time	40	Sec

Simulation Results :

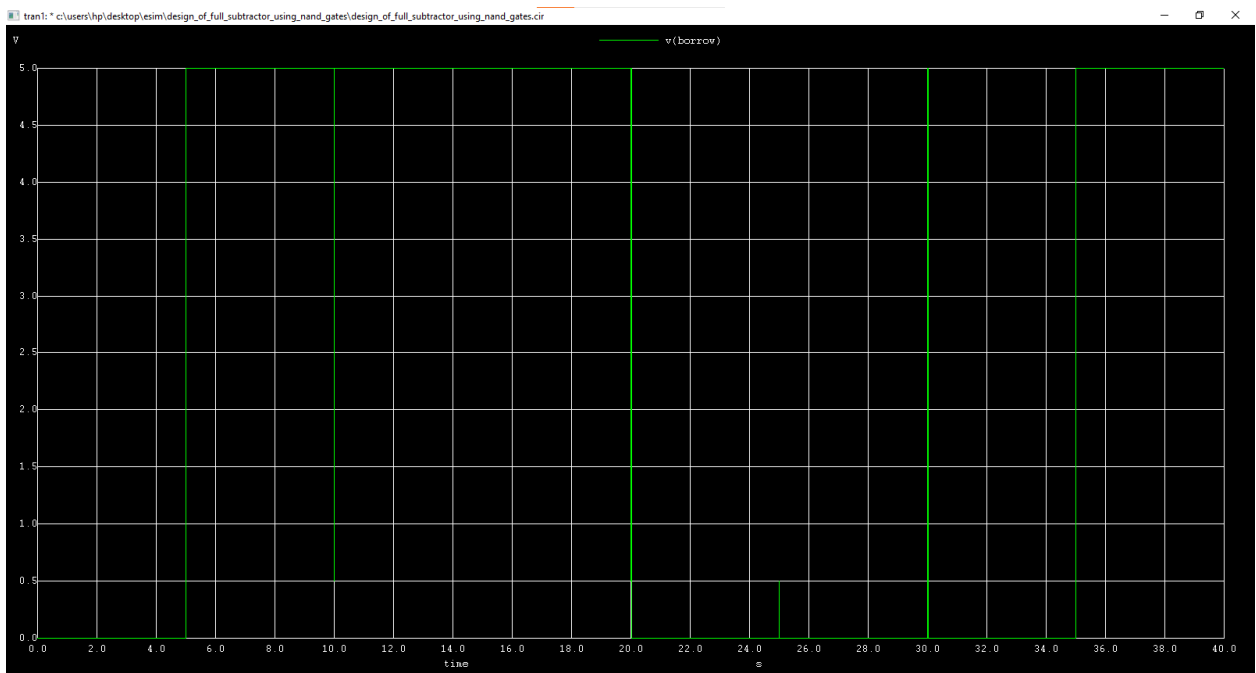## 1) Ngspice plots:

Input waveforms:

A:

B:

Bin:
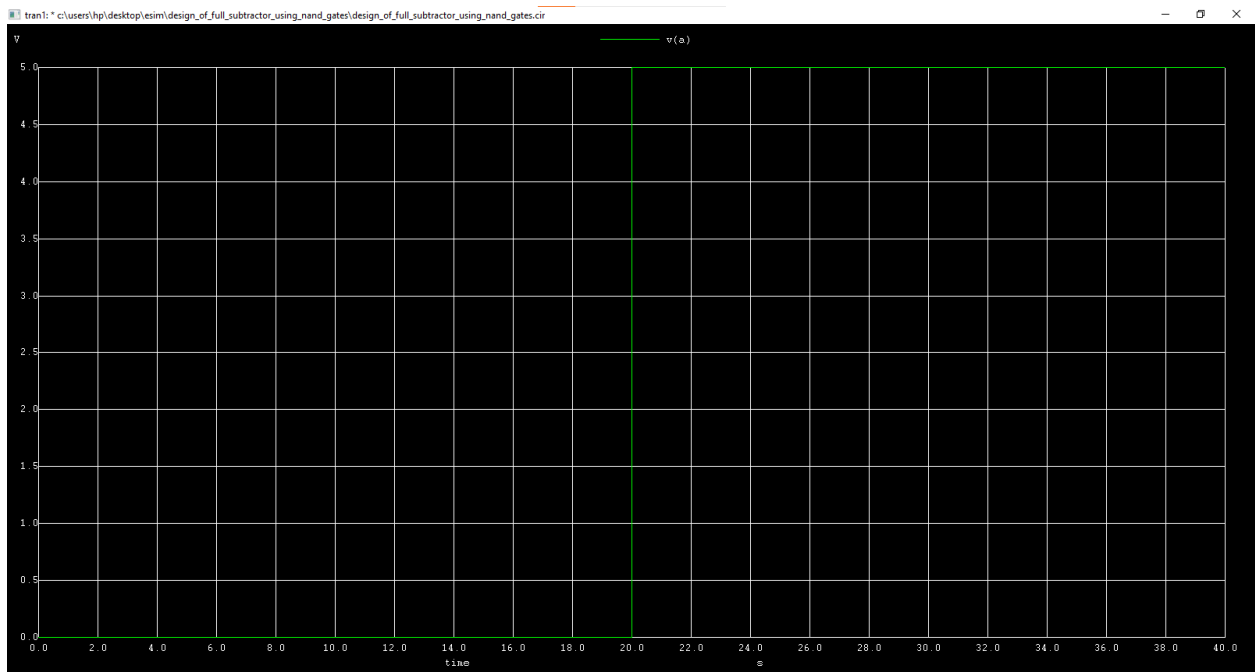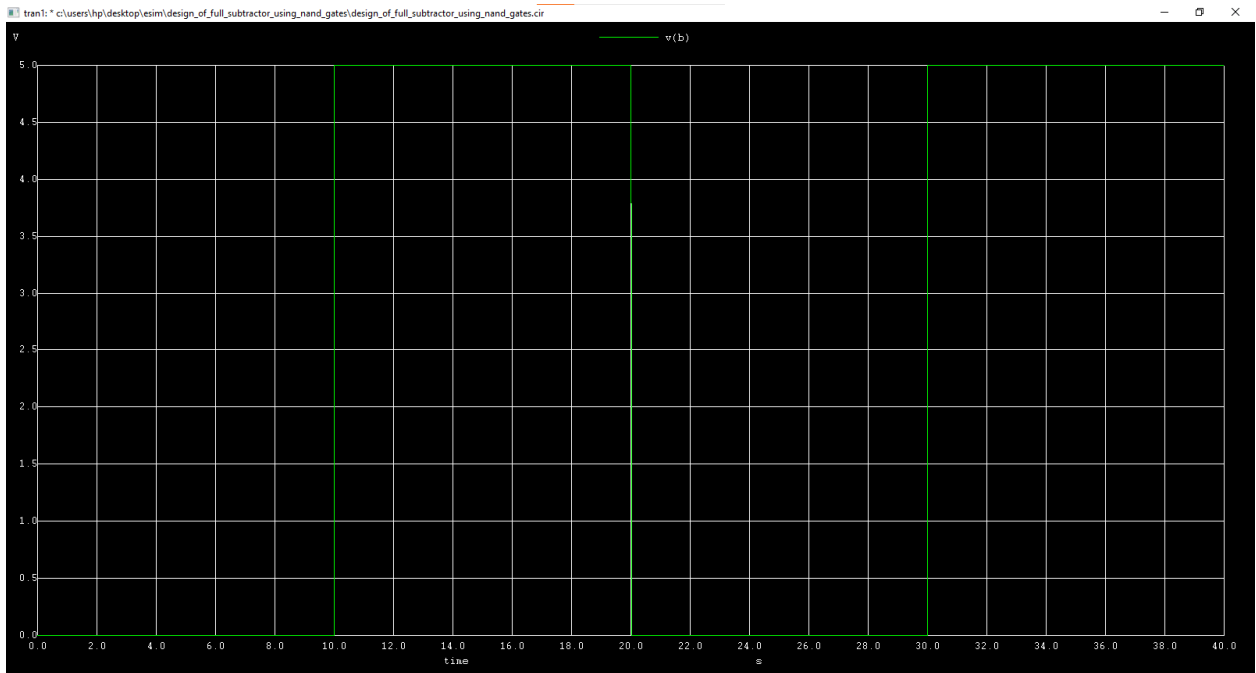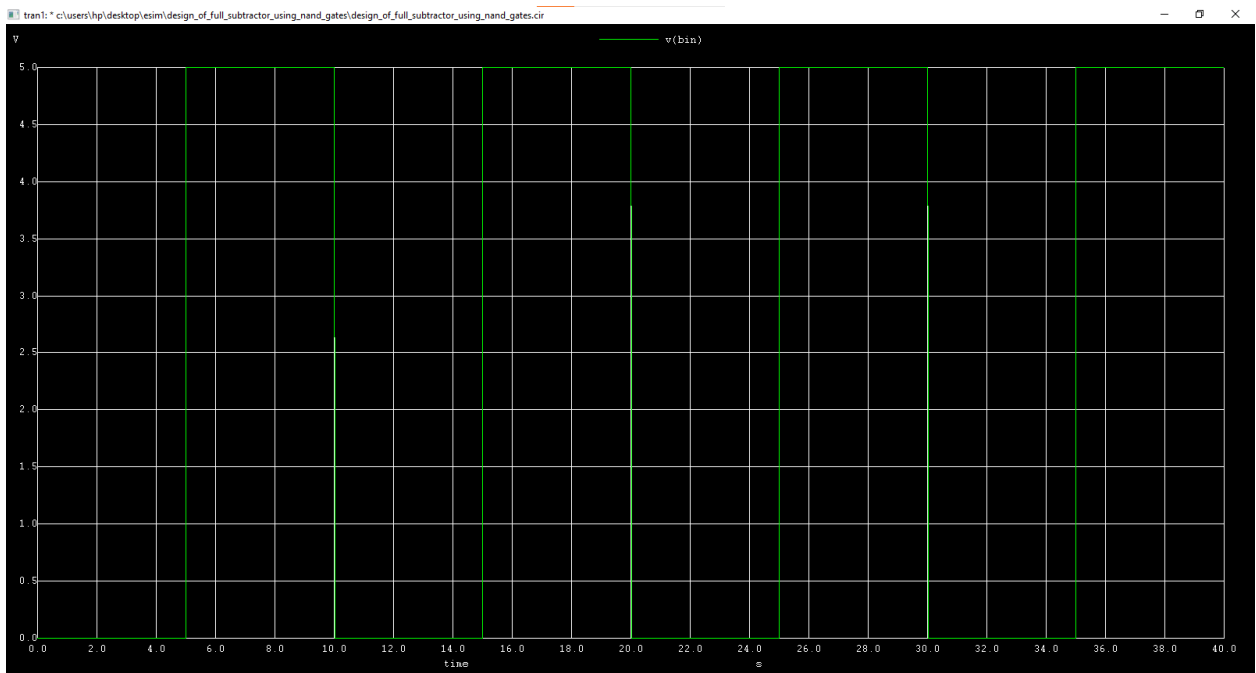
Output Waveforms:
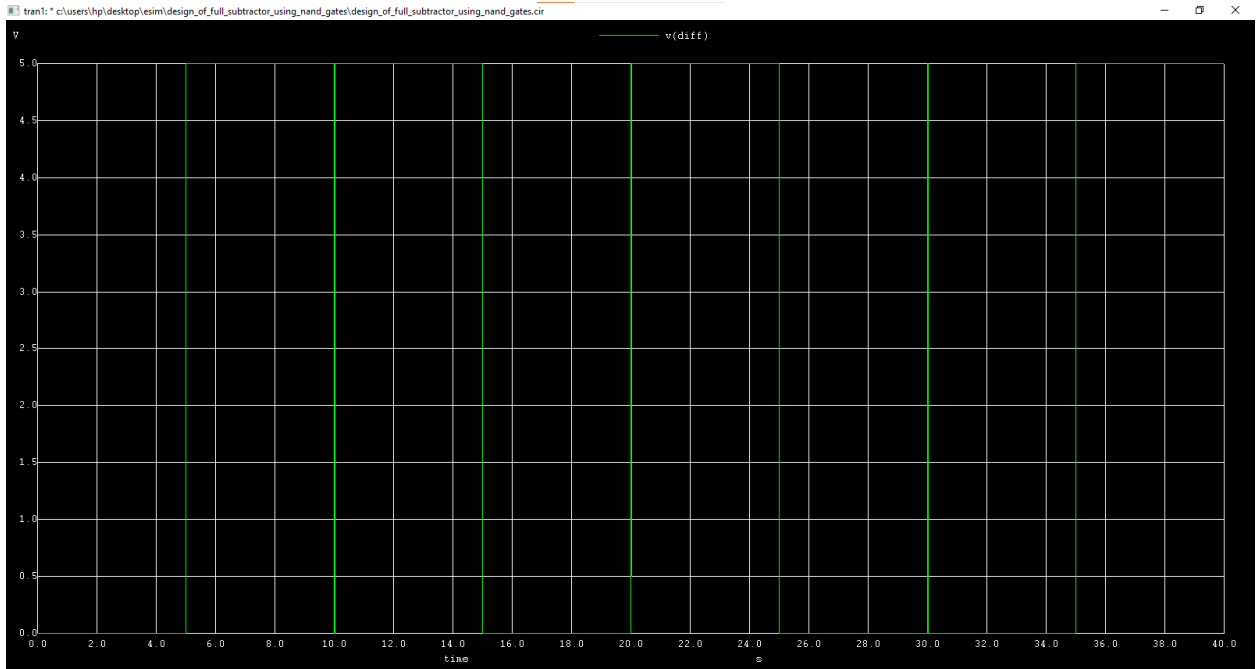
Diff:

Borrow:

2) Python plots:

Input waveforms:
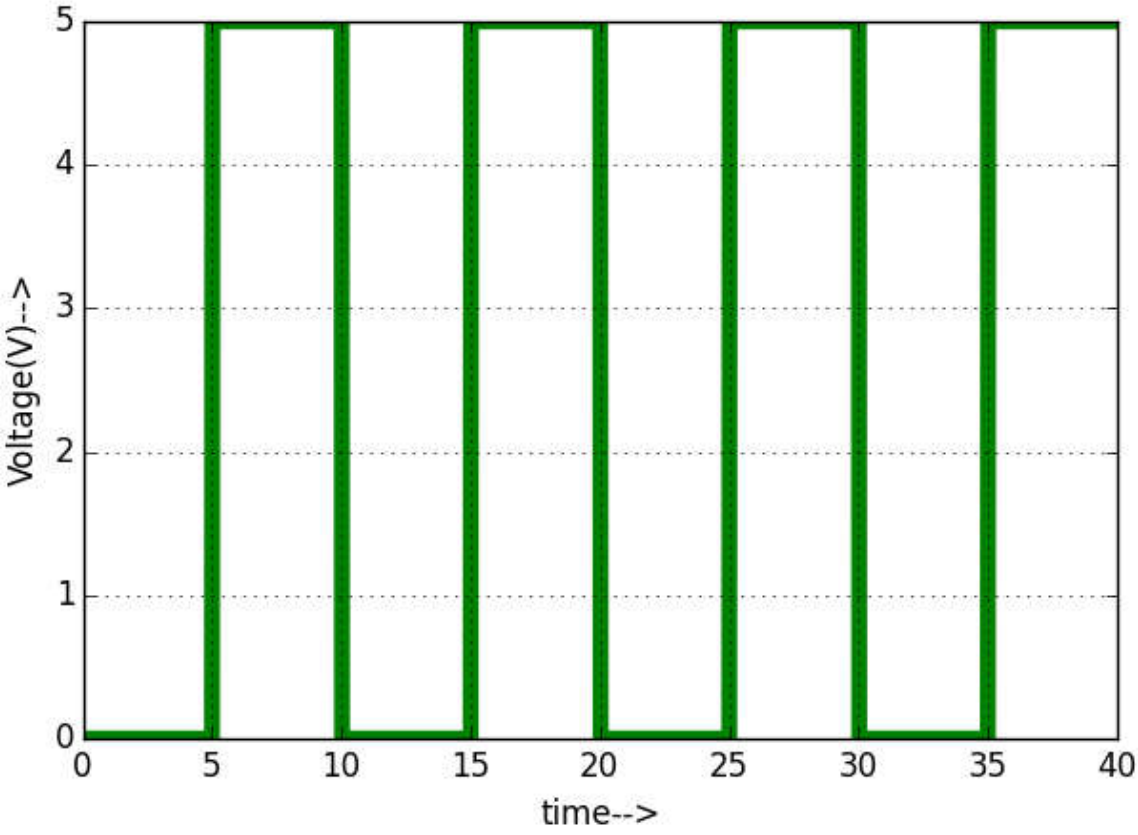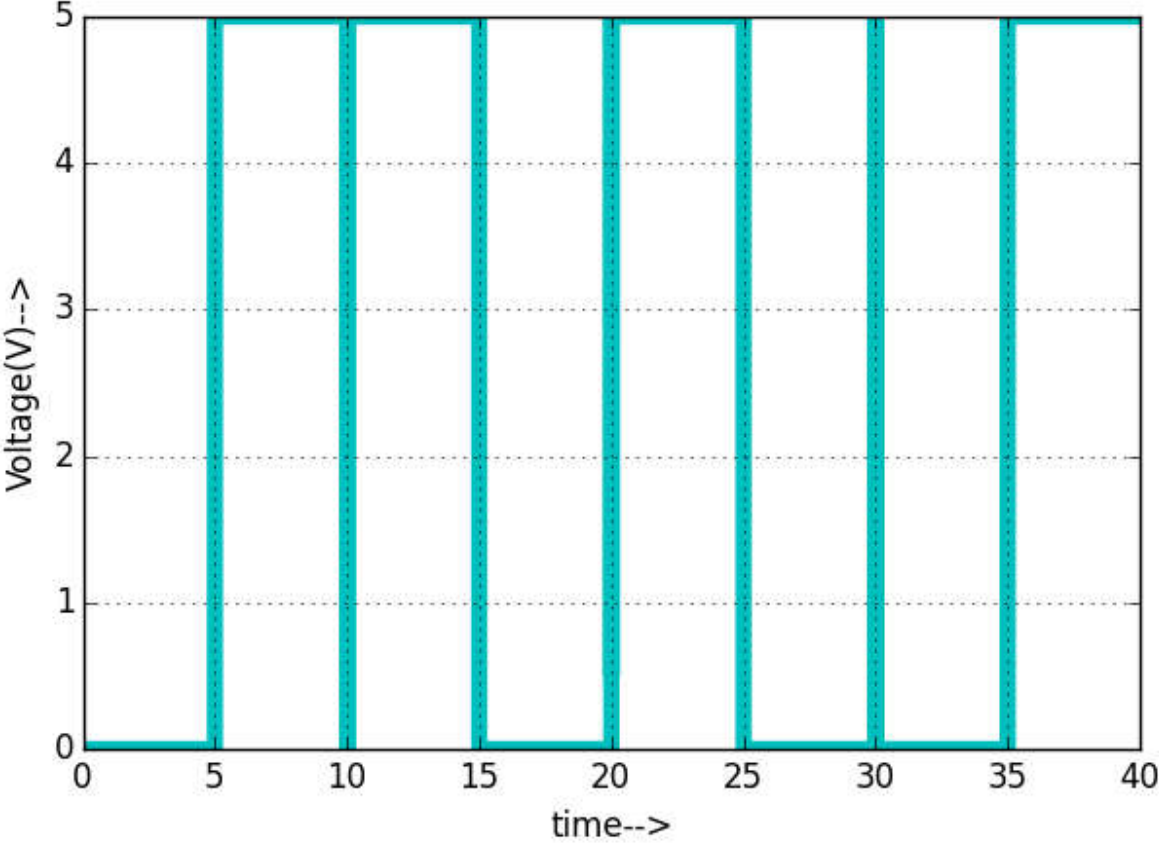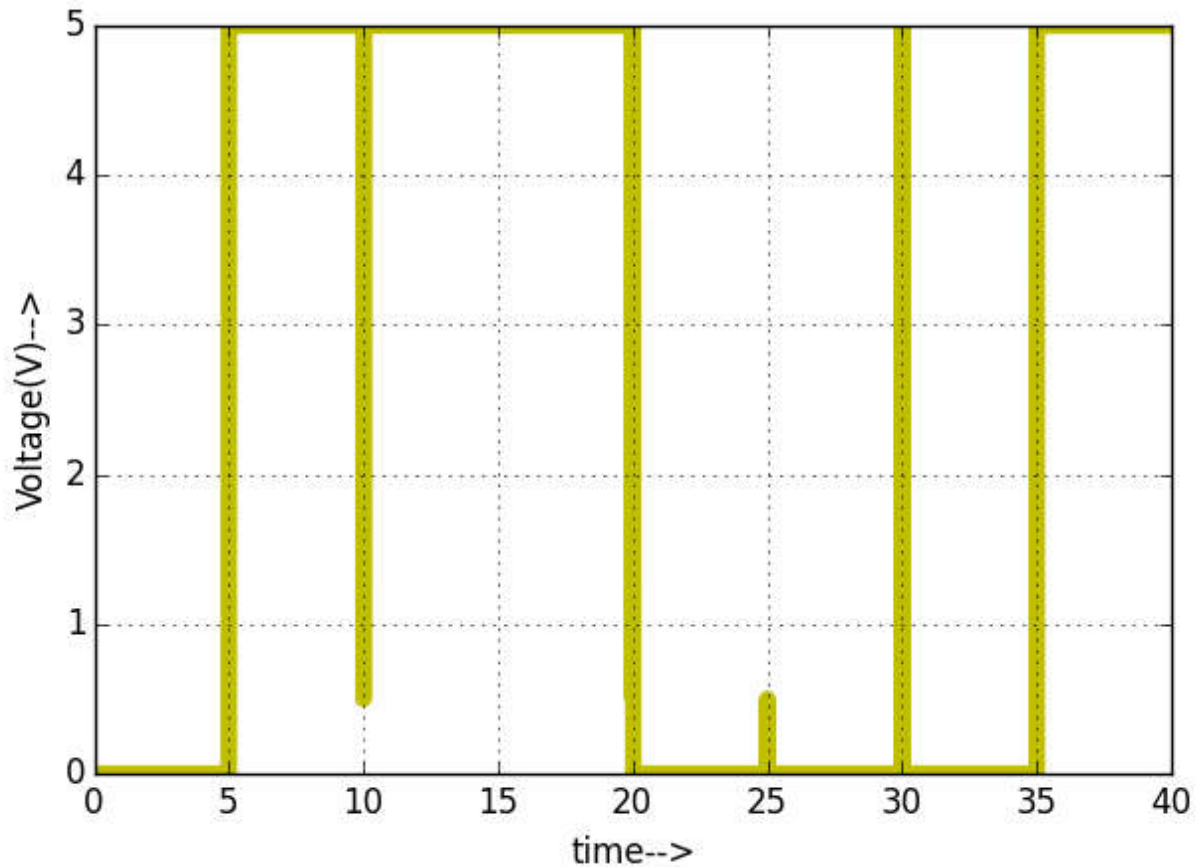
A:

B:

Bin:
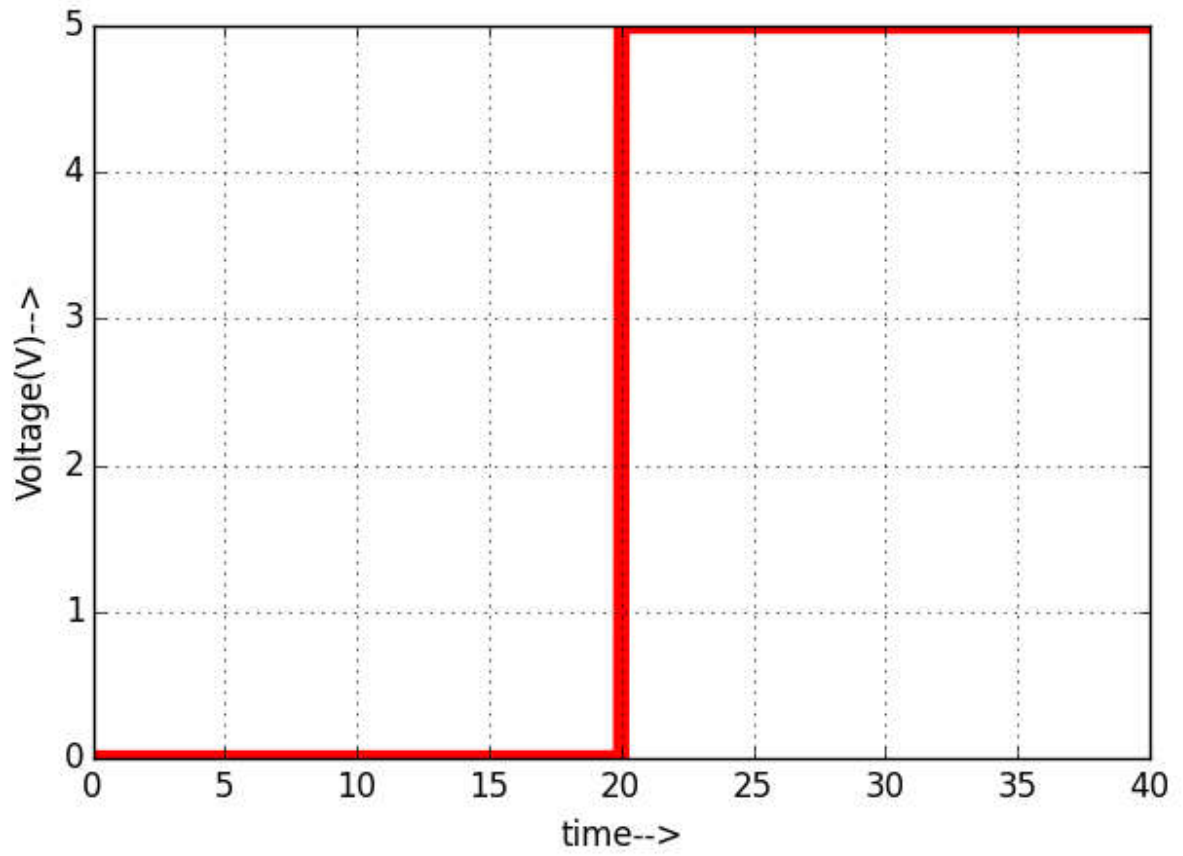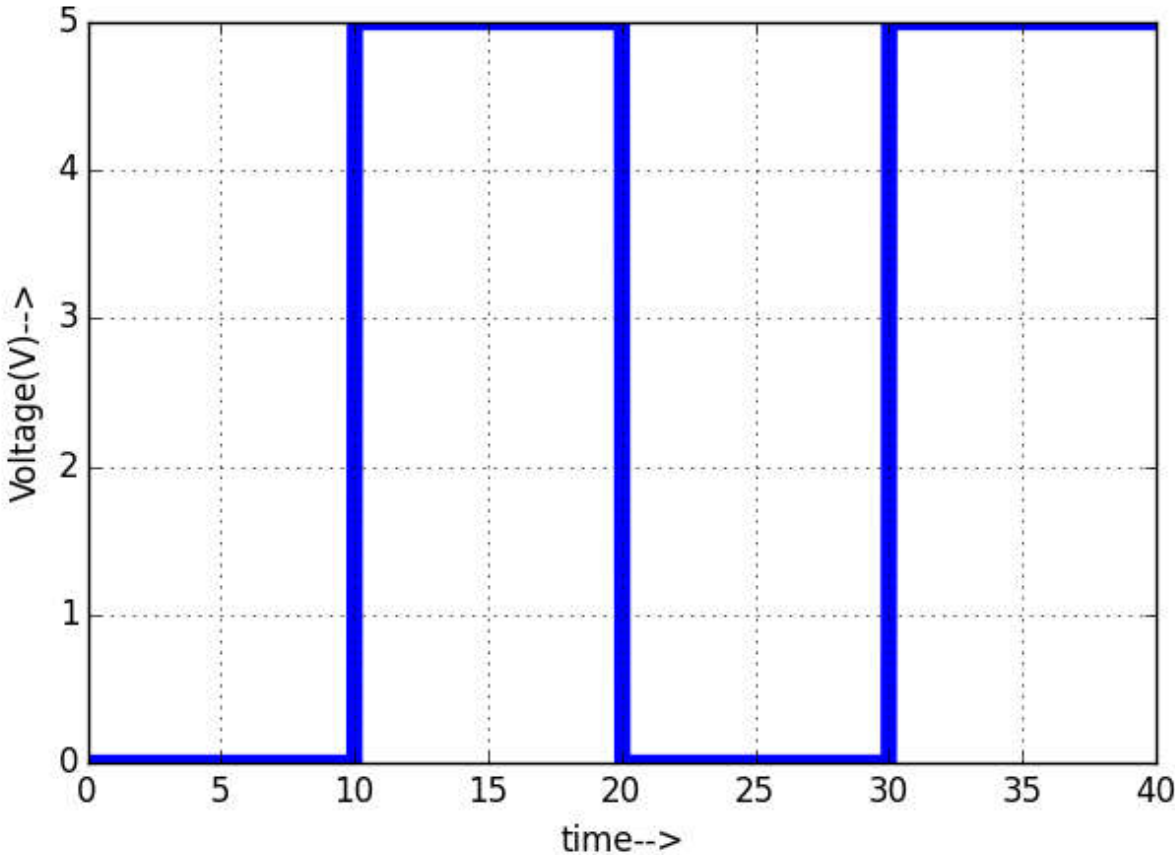
Output waveforms:

Diff:

Borrow:

Conclusion:

Thus, we have studied the design of full subtractor using nand gates using eSim and we get the appropriate waveforms.

References:

- https://www.ahirlabs.com/2017/06/09/adder-and-subtractor/
- https://www.geeksforgeeks.org/full-subtractor-in-digital-logic/