

Circuit Simulation Project

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

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Project Guide: Dr. Maheswari. R

Title: Design of Full subtractor using 4×1 multiplexer as a subcircuit

Theory:

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 B out represent the difference and output borrow, respectively.

We can implement a full subtractor using two 4×1 multiplexer and a not gate.

The truth table for subtracting two binary digits A and B with the borrow Bin is shown below:

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

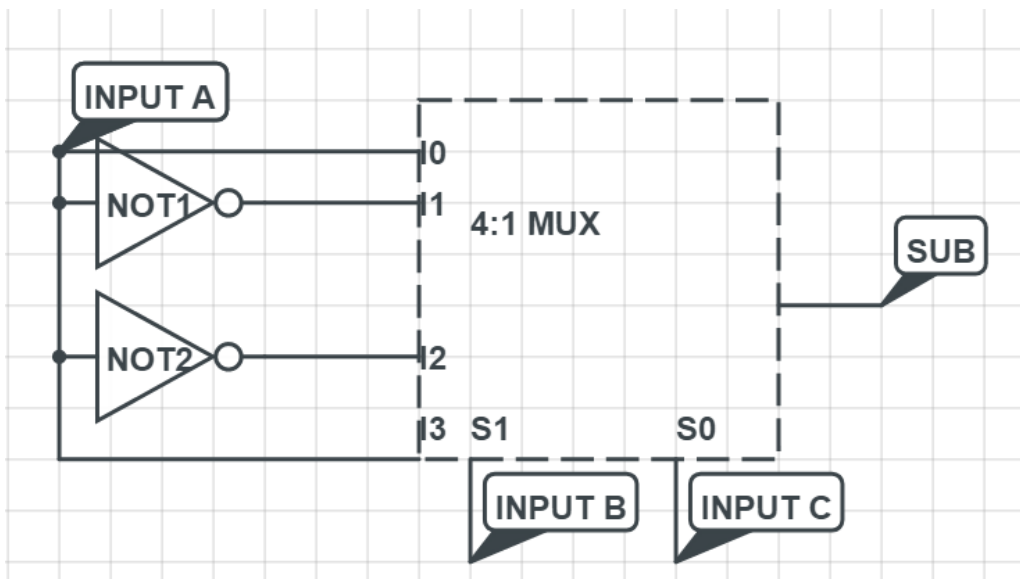
SOP form of difference and borrow bits:

Difference: $\Sigma m(1, 2, 4, 7)$

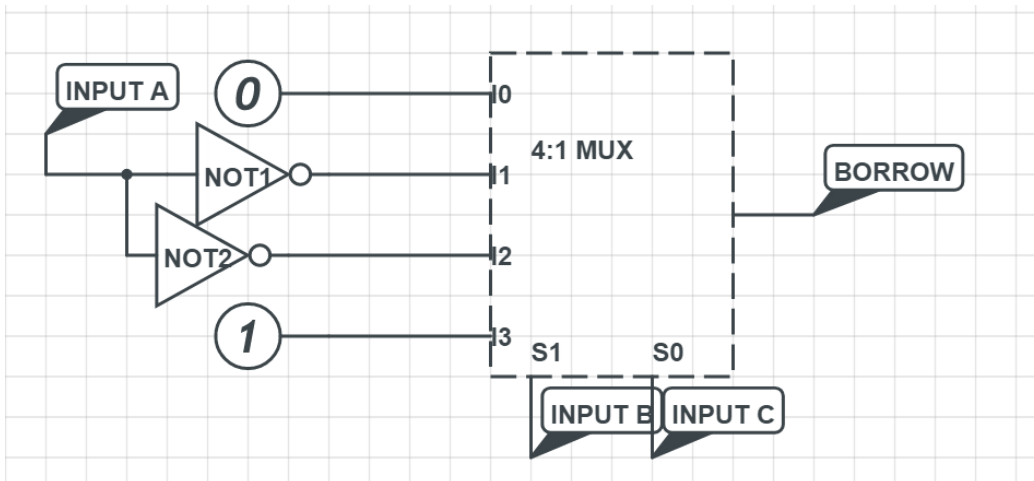
Borrow: $\Sigma m(1, 2, 3, 7)$

We can use the multiplexers to get the difference and borrow as shown below:

Difference:

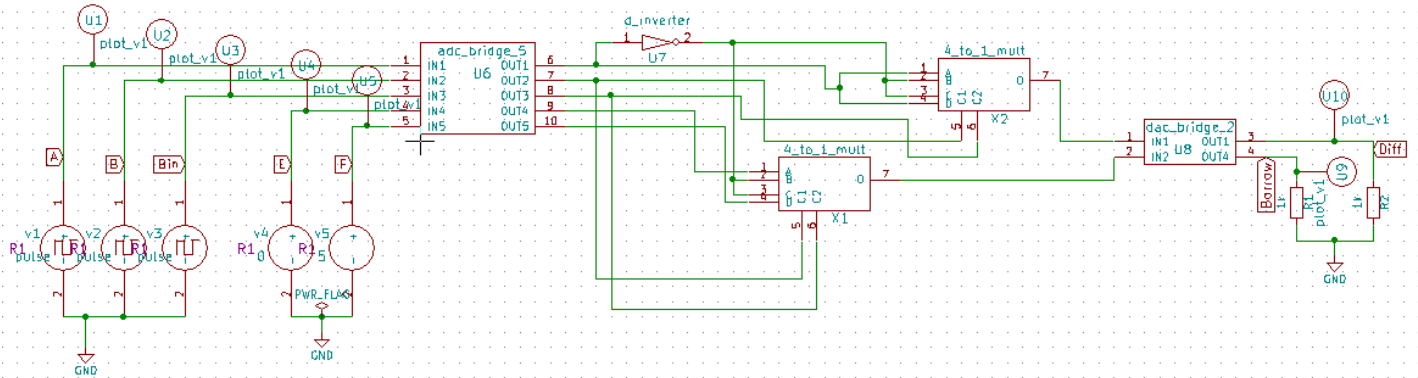


Borrow:

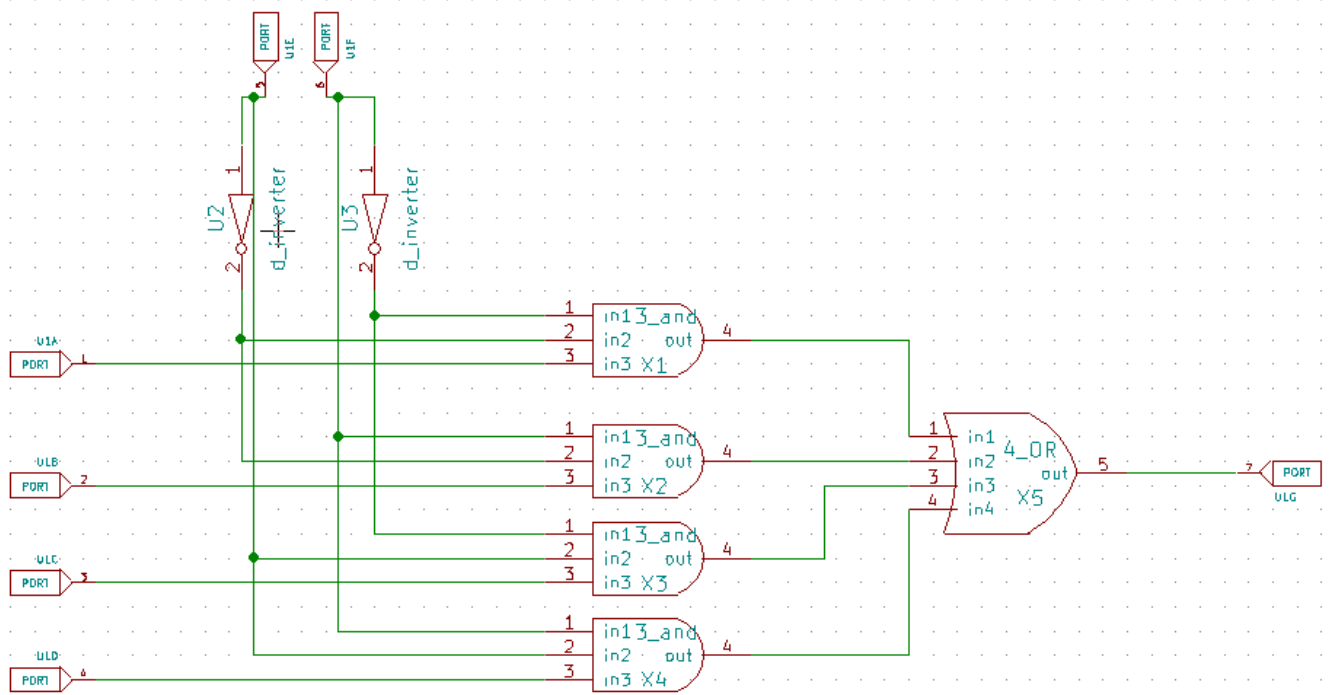


Circuit Diagrams: -

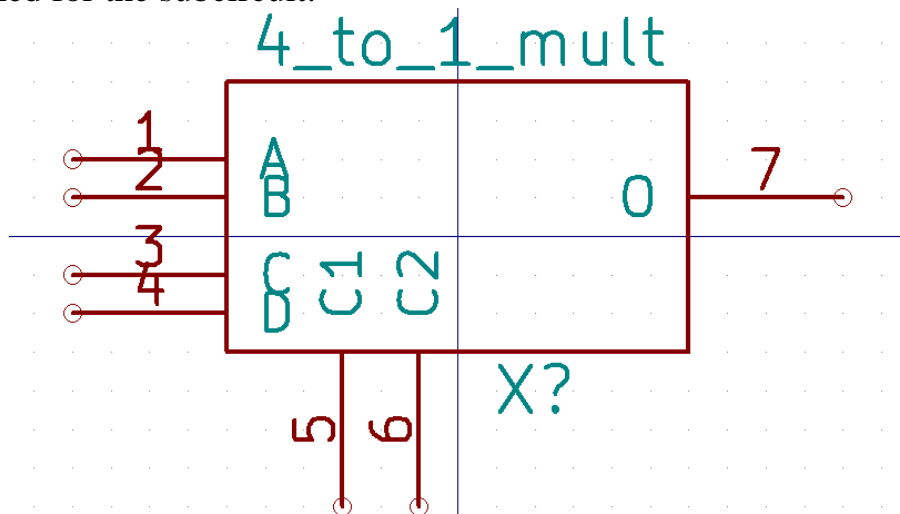
This is the main functional circuit schematic for the full subtractor which uses a subcircuit (4×1 multiplexer):



The structure of the 4×1 multiplexer subcircuit used:



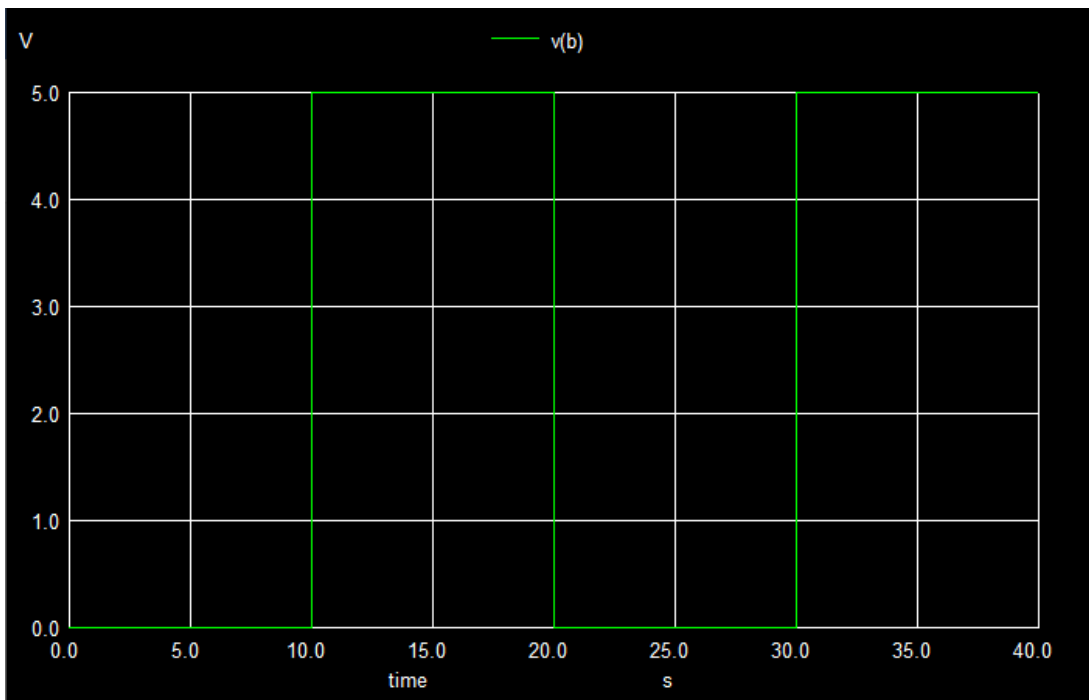
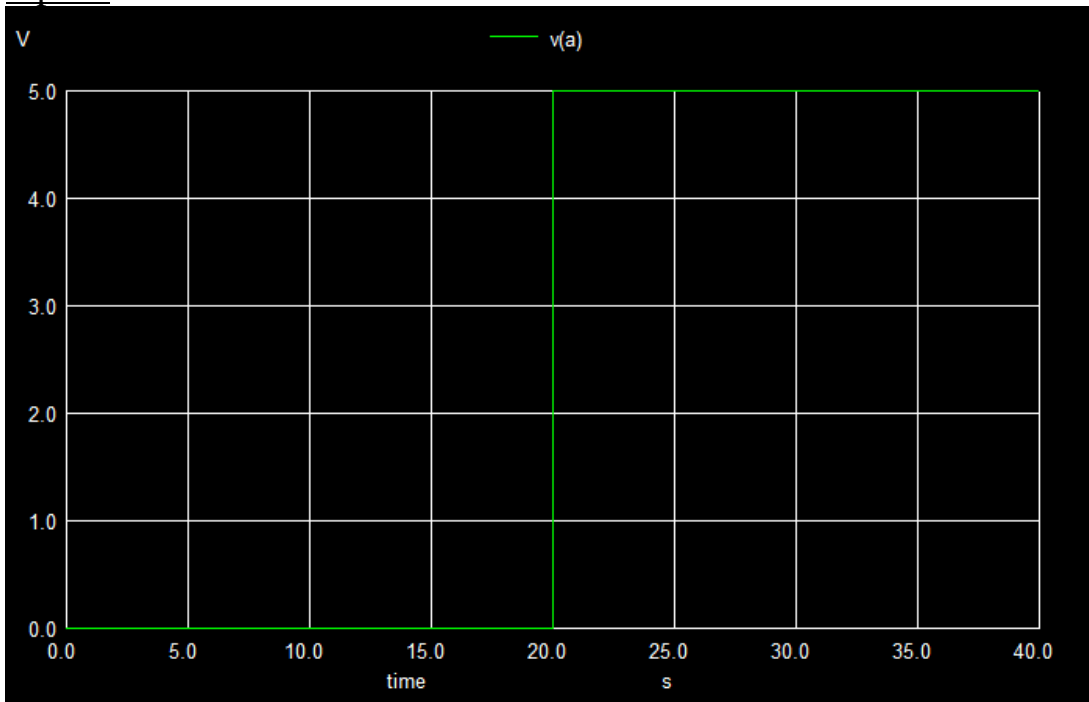
The symbol defined for the subcircuit:

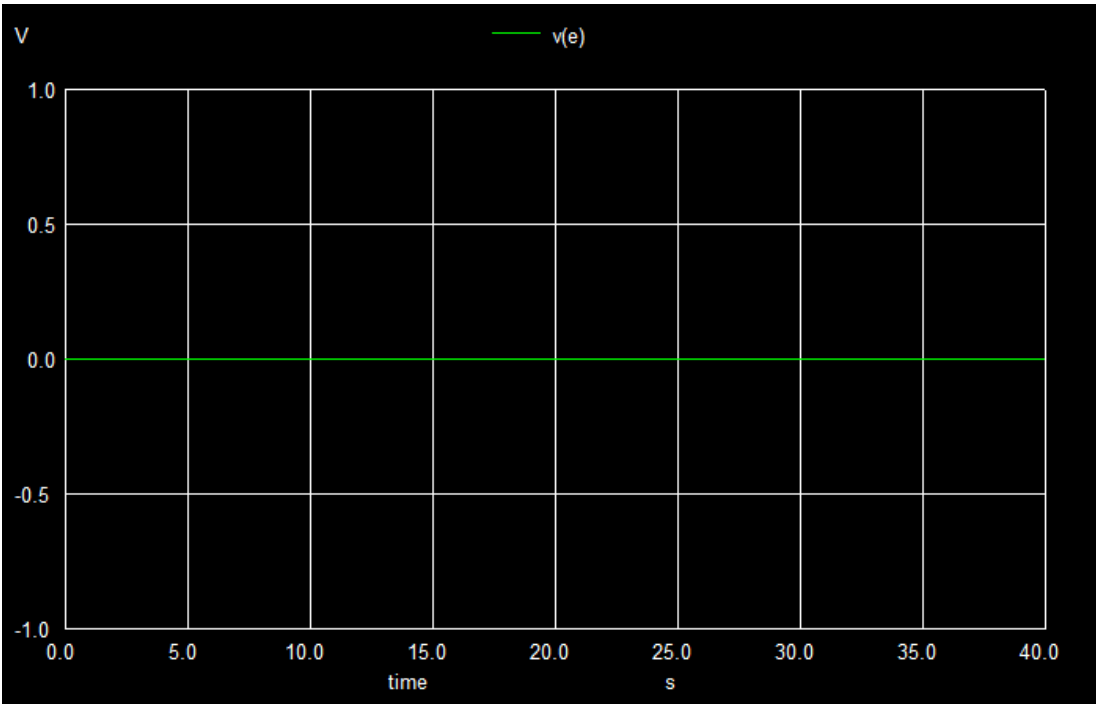
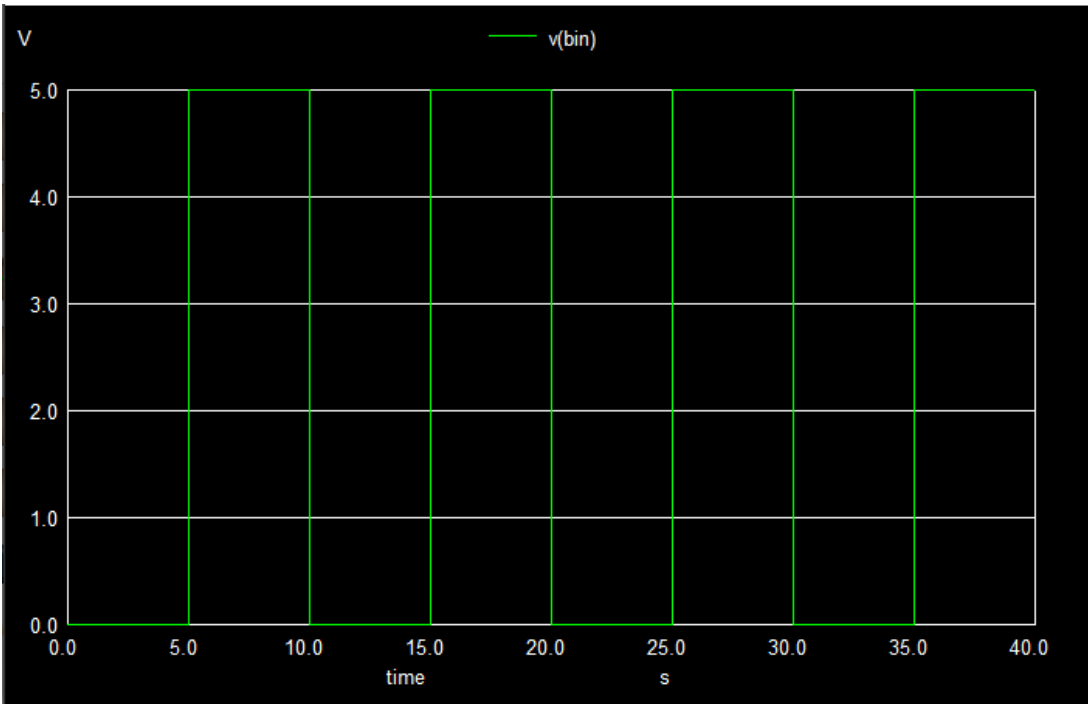


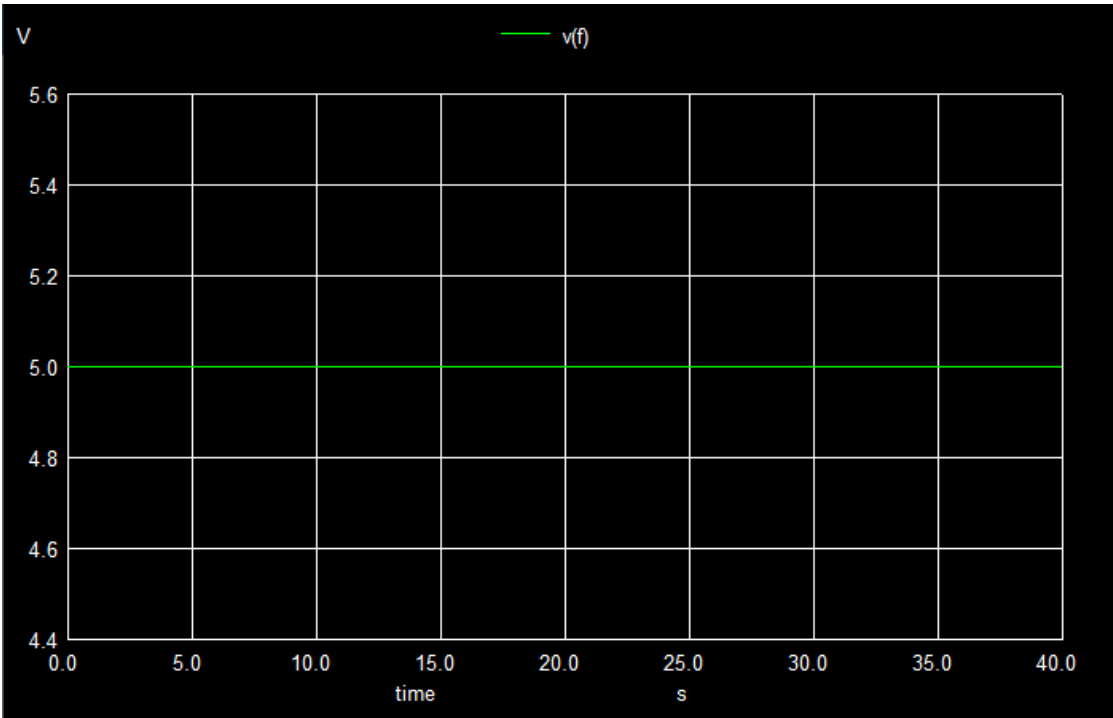
Result:

Ngspice Plots:

Inputs:

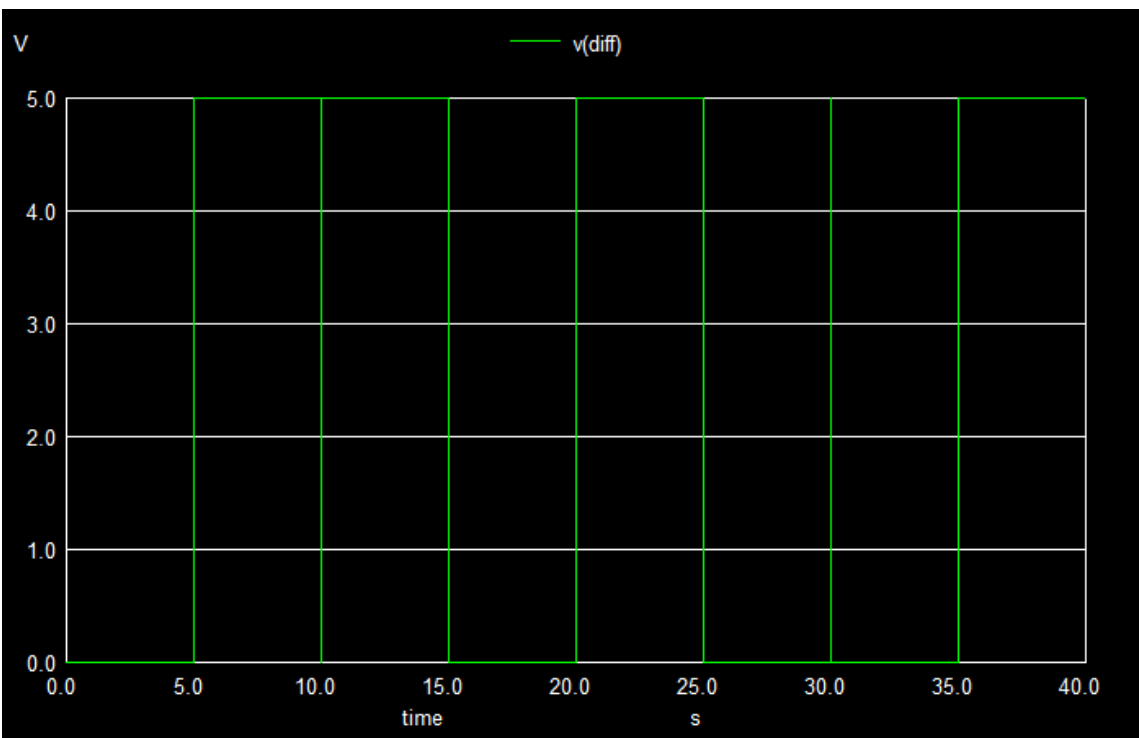




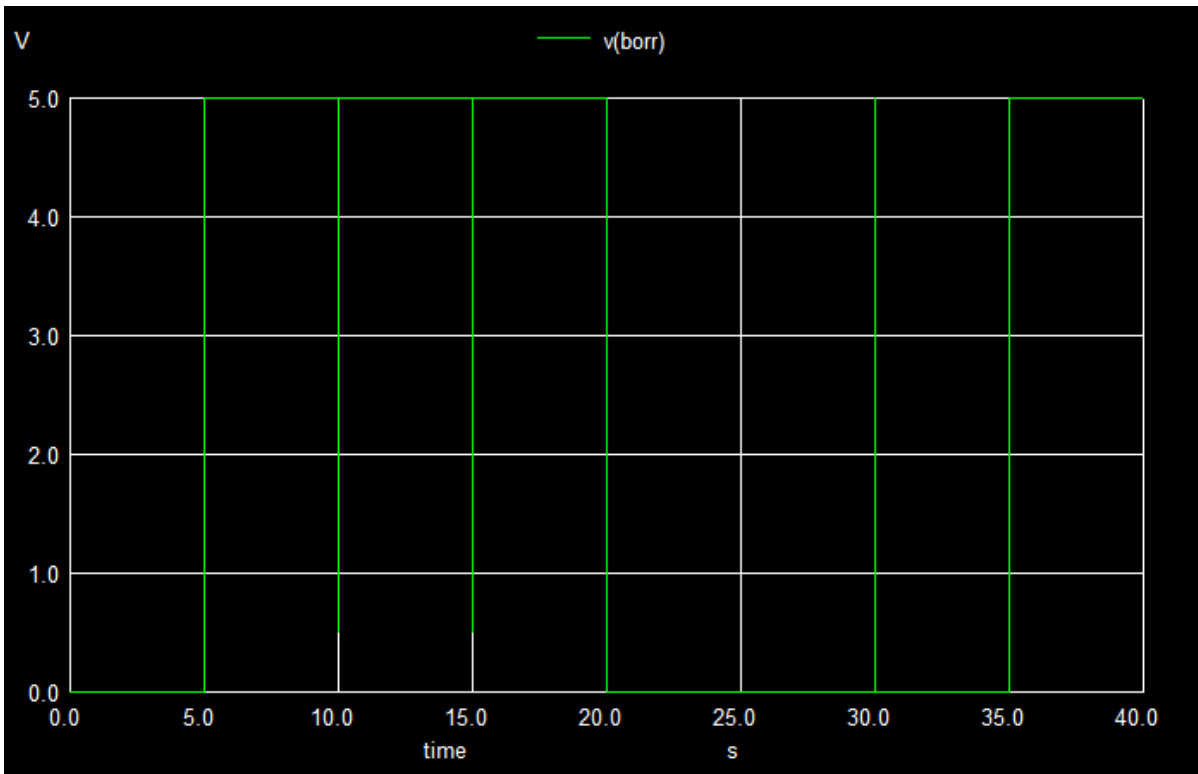


Outputs:

Difference:



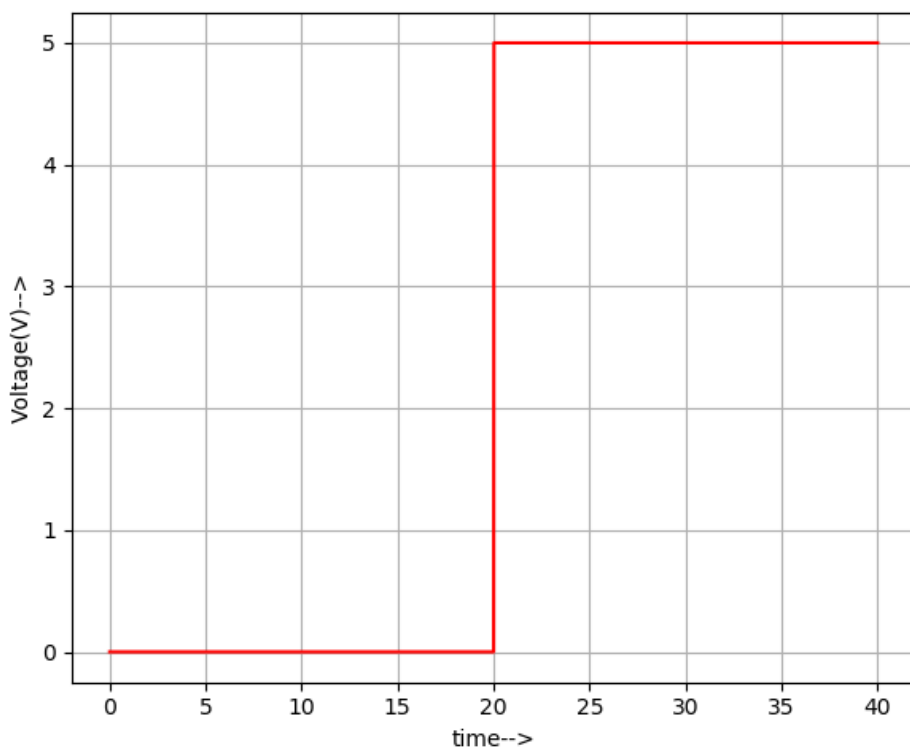
Borrow:



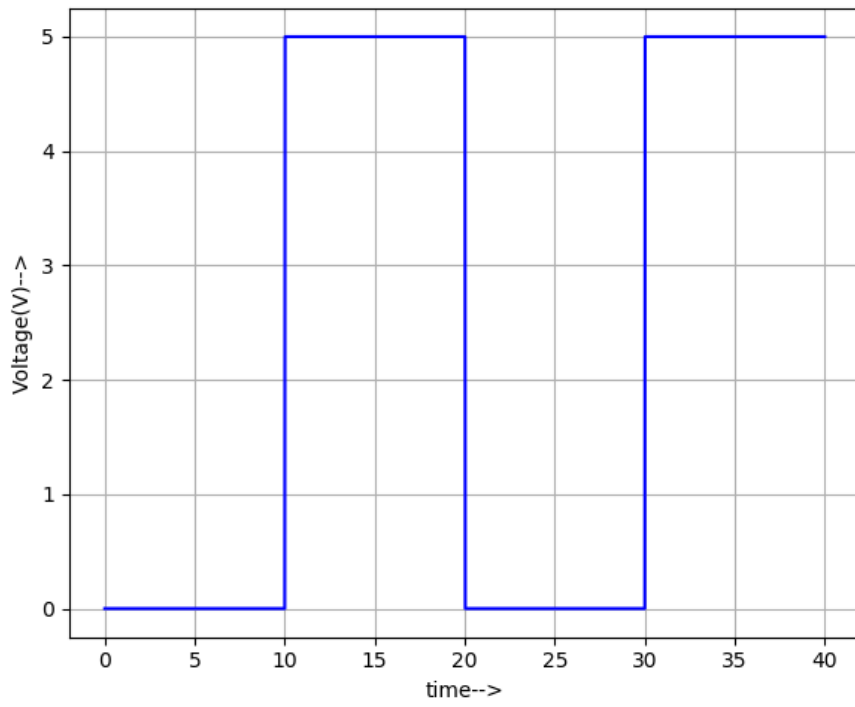
Python Plots:

Inputs:

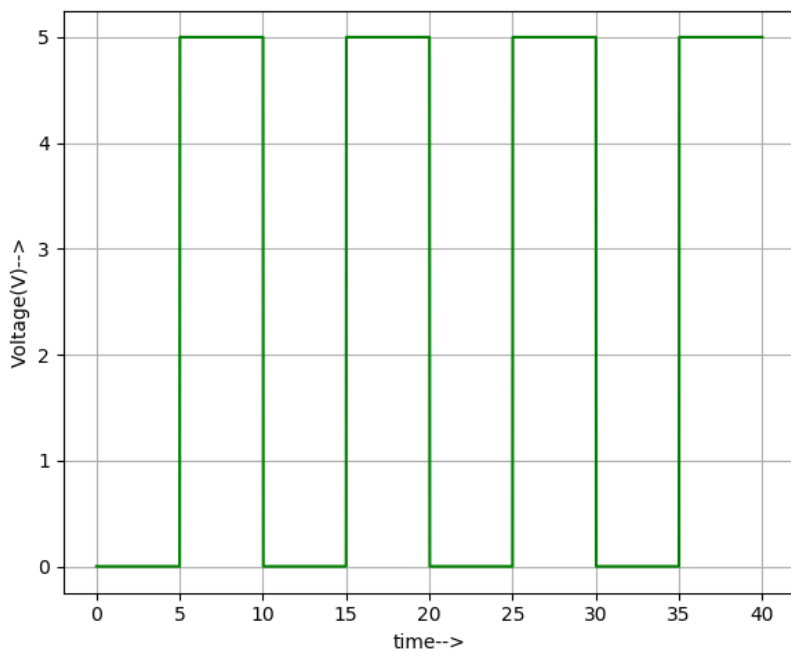
A



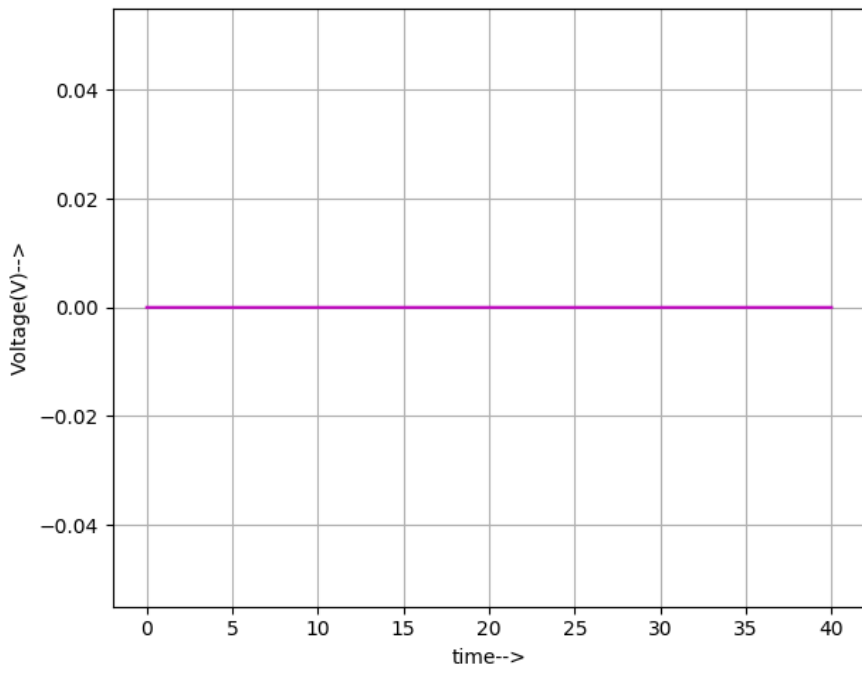
B



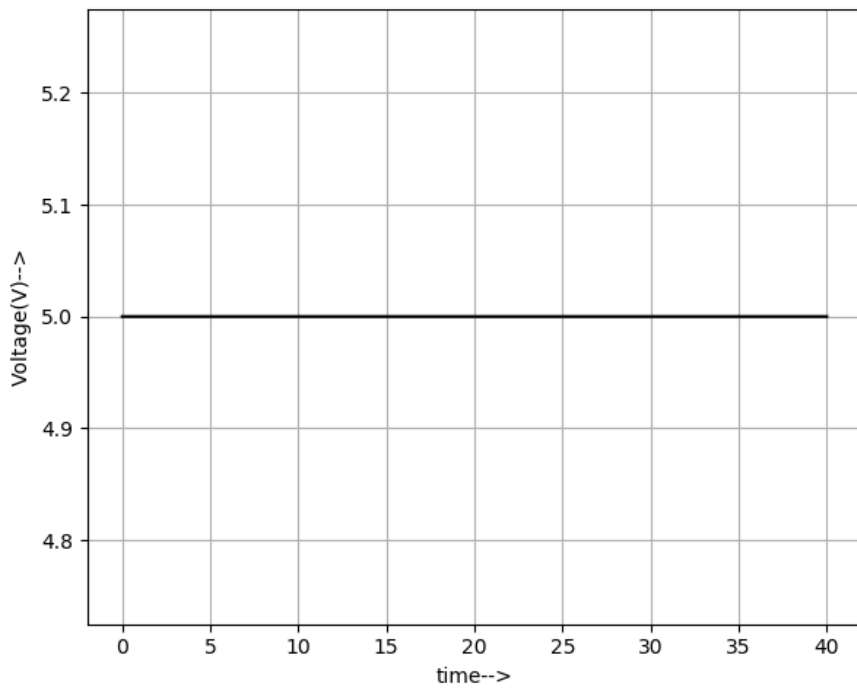
Bin



E

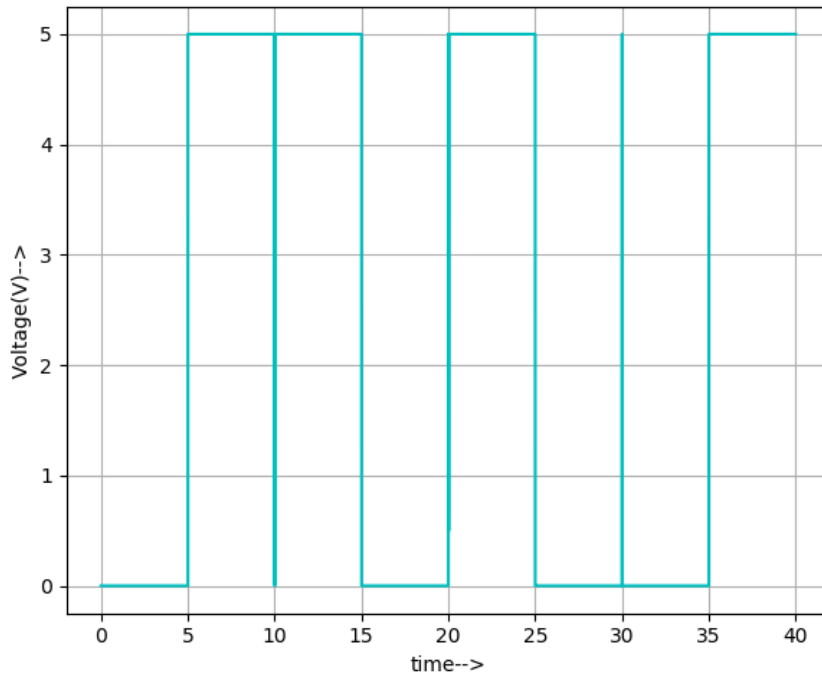


F

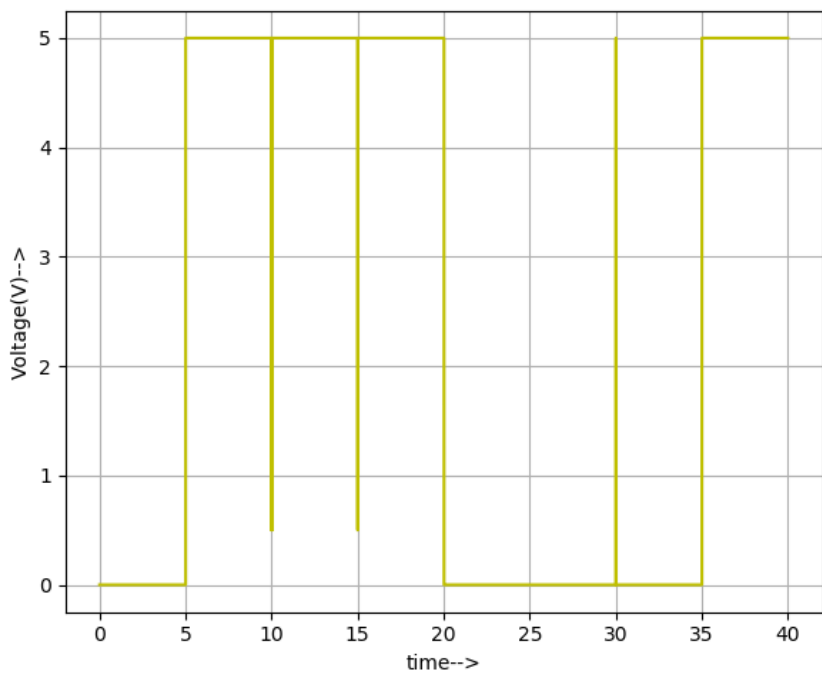


Outputs:

Difference:



Borrow:



References: -

- https://www.tutorialspoint.com/digital_circuits/digital_circuits_multiplexers.htm
- <https://www.javatpoint.com/full-subtractor-in-digital-electronics>