LAB Experiment 9
Boolean Function using Universal Gates

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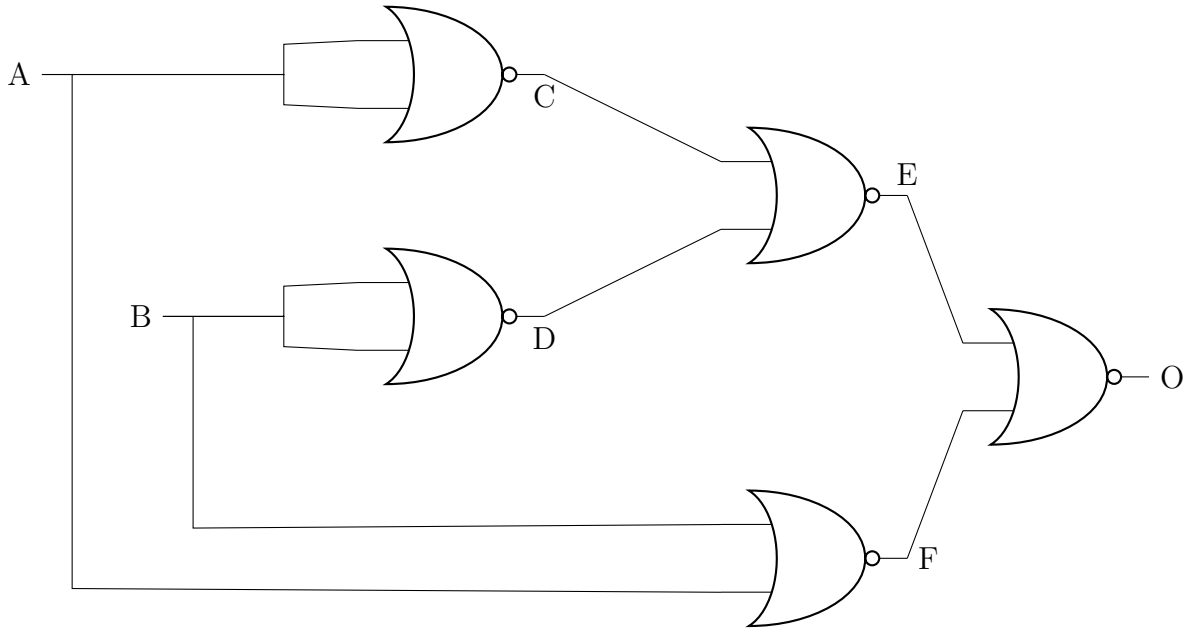
November 20,2020

1 Aim

Implement the below logic function in NgSpice using NOR gates using subcircuits.

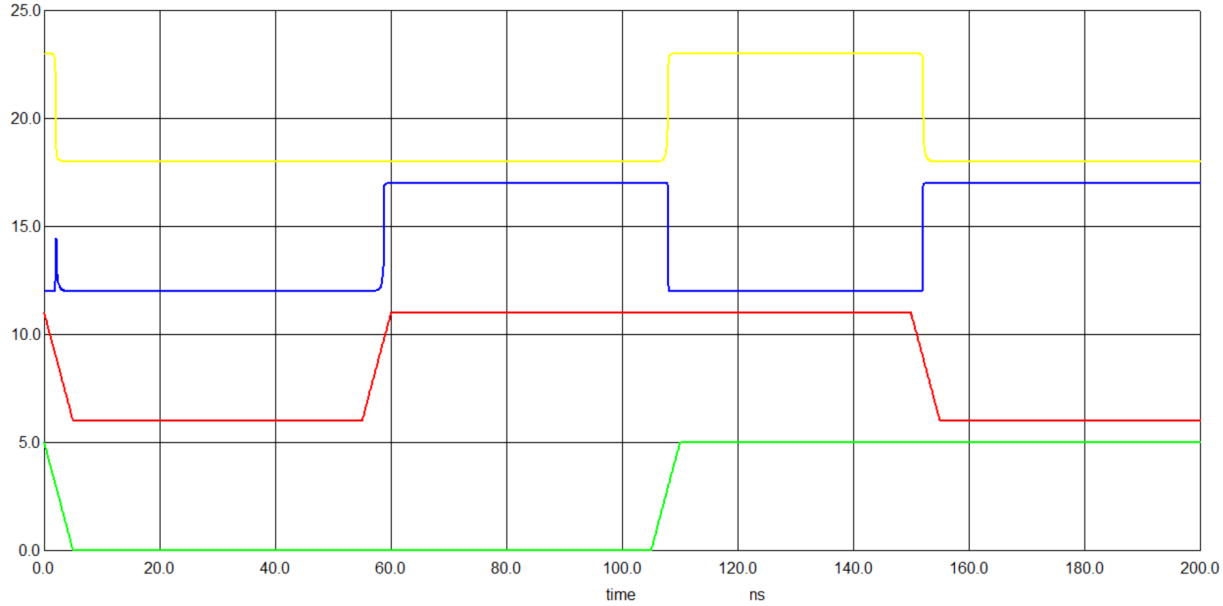
Input1	Input 2	Output1	Output2
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

2 Procedure



Write the script for the above circuit in NgSpica and plot nodes A,B,O,E as $V_{in1}, V_{in2}, V_{out1}, V_{out2}$ respectively

3 Results



4 Understanding

From the circuit diagram we can see that -

- $C = \overline{A + A} = \overline{A}$ and D $= \overline{B + B} = \overline{B}$
- So E $= \overline{\overline{A} + \overline{B}}$ = A.B = AND(A,B)
- O $= \overline{E + F} = \overline{A.B + \overline{A + B}} = \overline{A.B + \overline{A + B}} = \overline{A.B}.\overline{\overline{A + B}} = A.\overline{B} + \overline{A}.B$ $= (\overline{A} + \overline{B}).(A + B)$ = XOR(A,B)

And we can check that the above plot follows the below truth table

$A = V_{in1}(Green)$	$B, V_{in2}(Red)$	$O, V_{out1}(Blue)$	$E, V_{out2}(Yellow)$
0	0	0	0
0	1	1	0
1	1	0	1
1	0	1	0

5 Conclusion

We can see that Output1 corresponds to a XOR gate and Output2 to AND gate.
Both of these gates can be combined to construct a half adder circuit which is used to add two binary digits.
XOR gate gives the sum and AND gate gives the carry.