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CMOS DESIGN PROJECT REPORT

4-Bit Gray to Binary Converter

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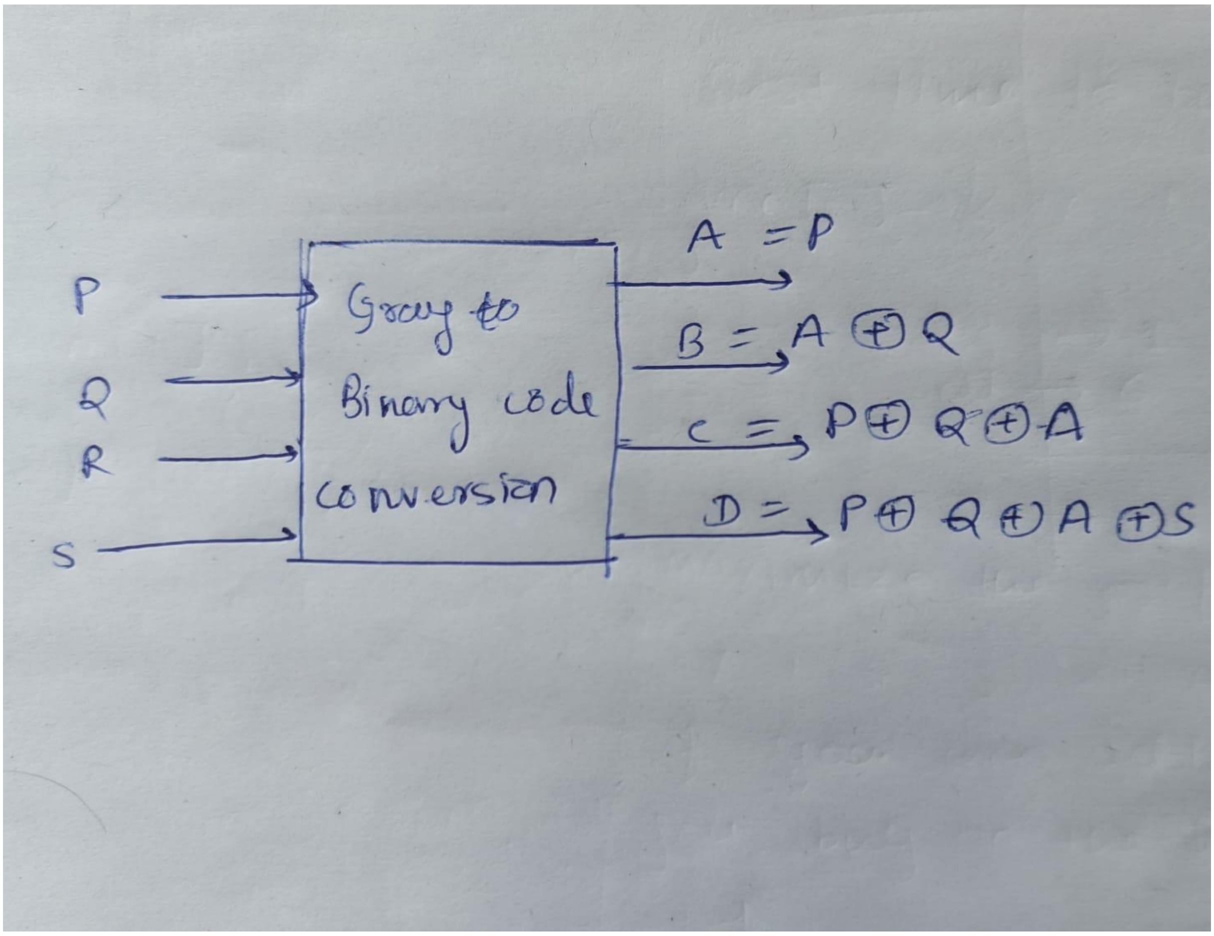
ABSTRACT:

- PROJECT – Implementation of 4-bit gary to binary code converter.
- Implementation – done by both layout and netlist
- Gray code is a binary code where two successive values differ in only one bit.
- It is used in many applications, such as digital communications, rotary encoders, and positioning systems.
- A gray code to binary converter is a device that converts a gray code input into its binary equivalent output. The purpose of this project is to design and implement a 4-bit gray to binary converter using basic logic gates

INTRODUCTION:

- For designing gray to binary converter I have used 4 xor gates and 1 and gate.
- basically xor gate takes the two inputs(here two bits) and implement the logic ~A.B+~BA on the two bits
- And the next xor gate will get input, the output of previous xor gate and a bit from gray code.

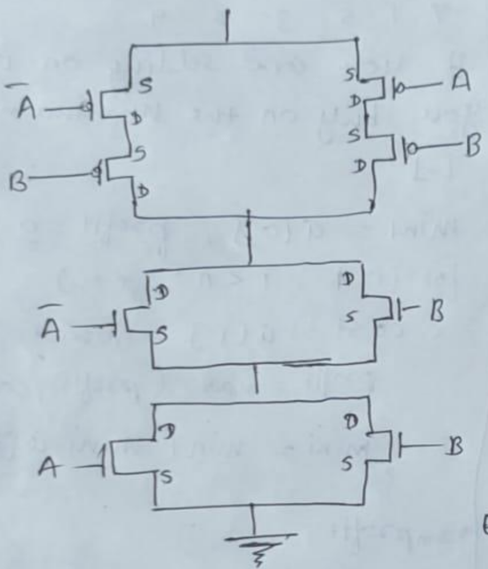
CIRCUIT DIAGRAM:



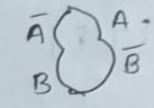
XOR gate

$$y = A\bar{B} + \bar{A}B$$
$$= \overline{(\bar{A}+B)} + \overline{(A+\bar{B})}$$
$$= \overline{(\bar{A}+B)(A+\bar{B})}$$

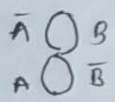
CMOS technology schematic.



pull up

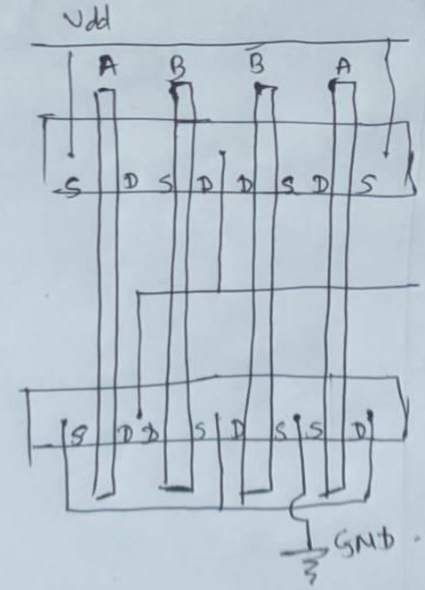


pull down



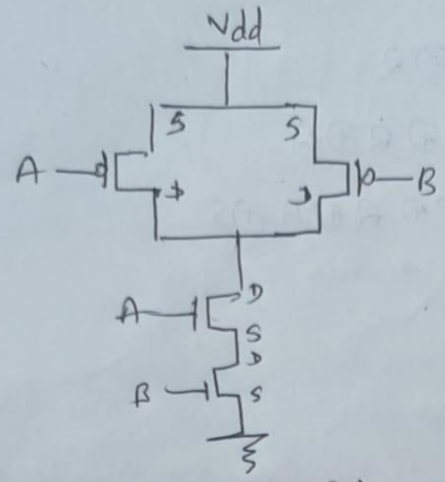
Euler Path = $\bar{A} \rightarrow B \rightarrow \bar{B} \rightarrow A$

layout

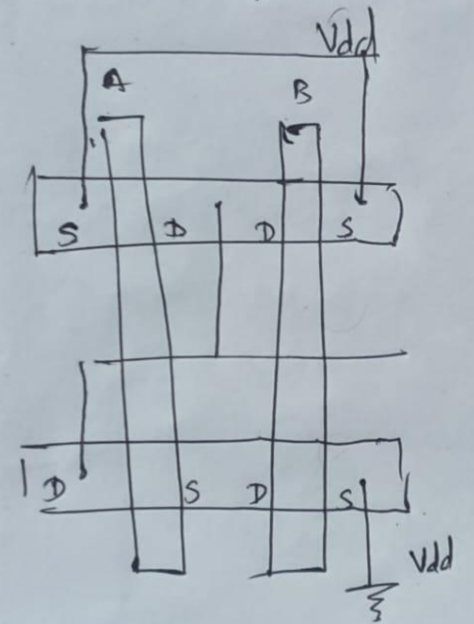


And Gate

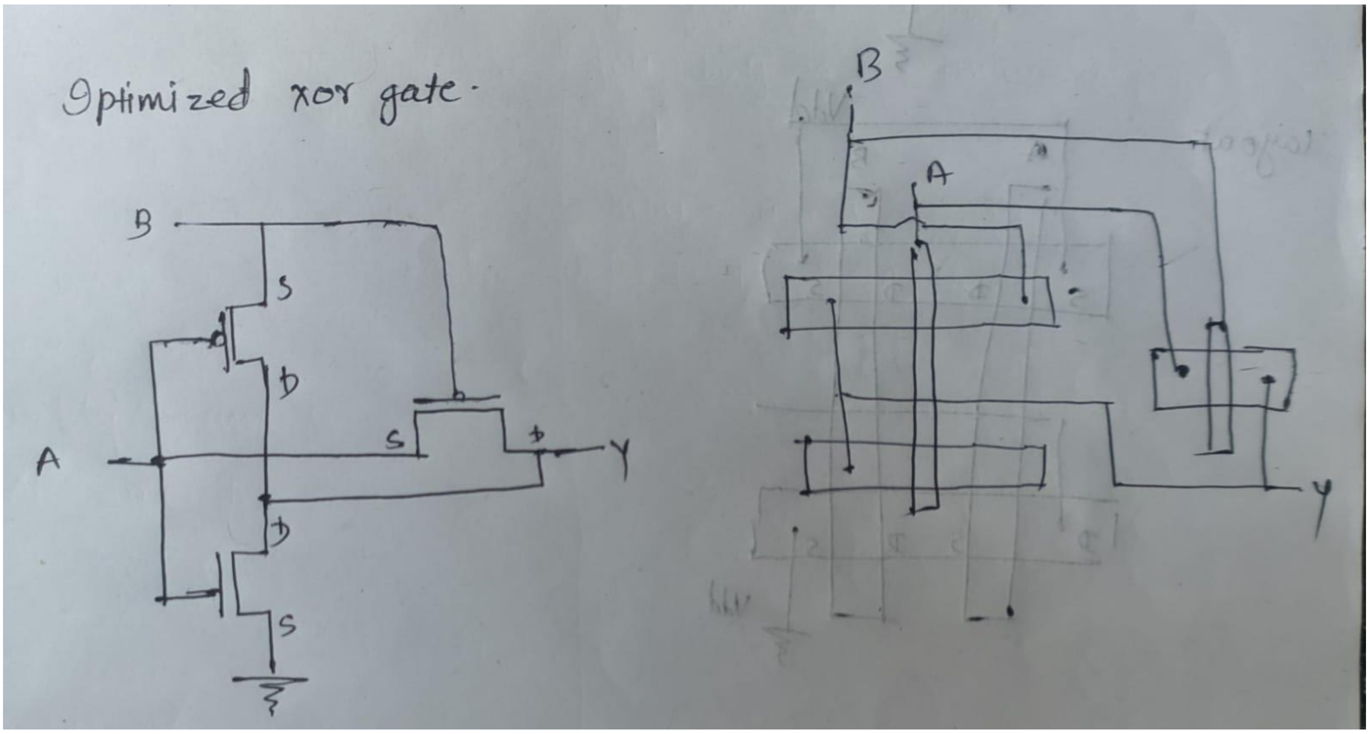
$Y = A \cdot B.$

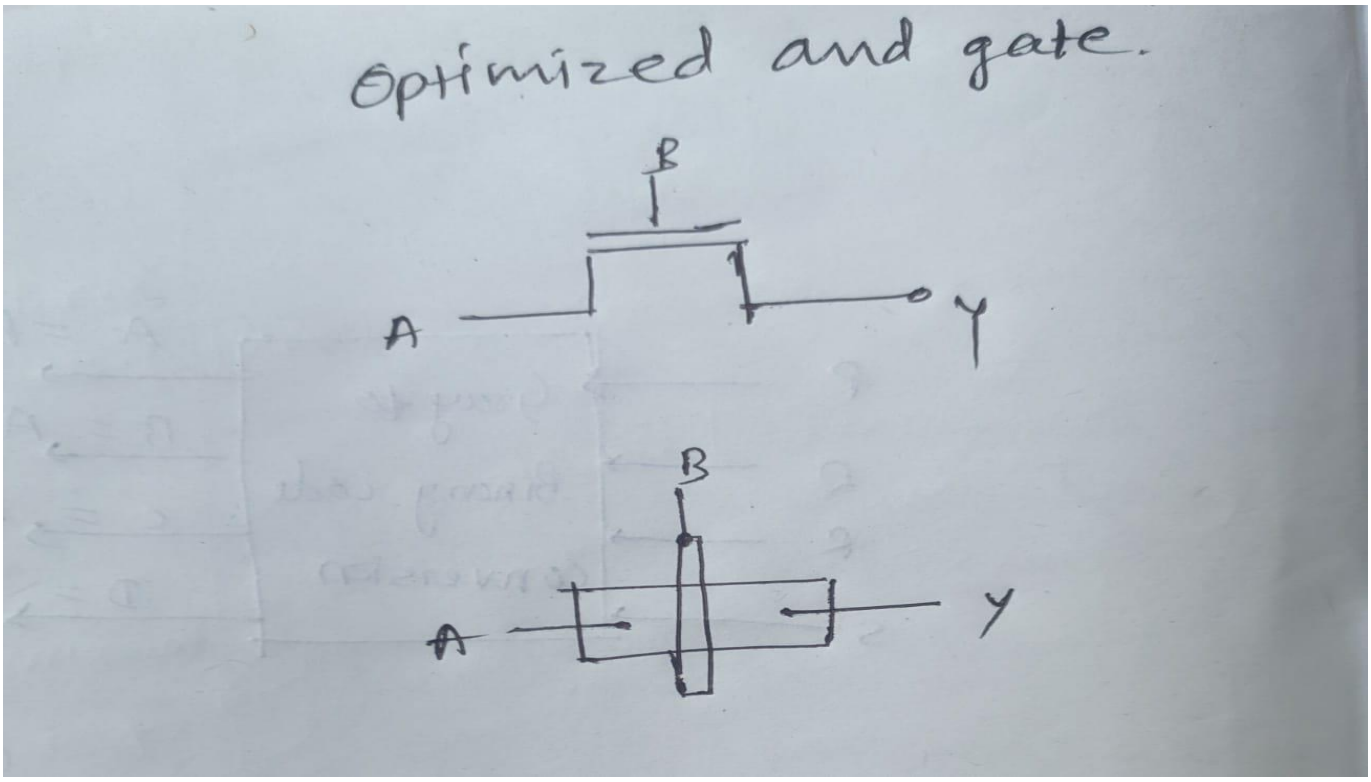


Layout



Optimized circuit





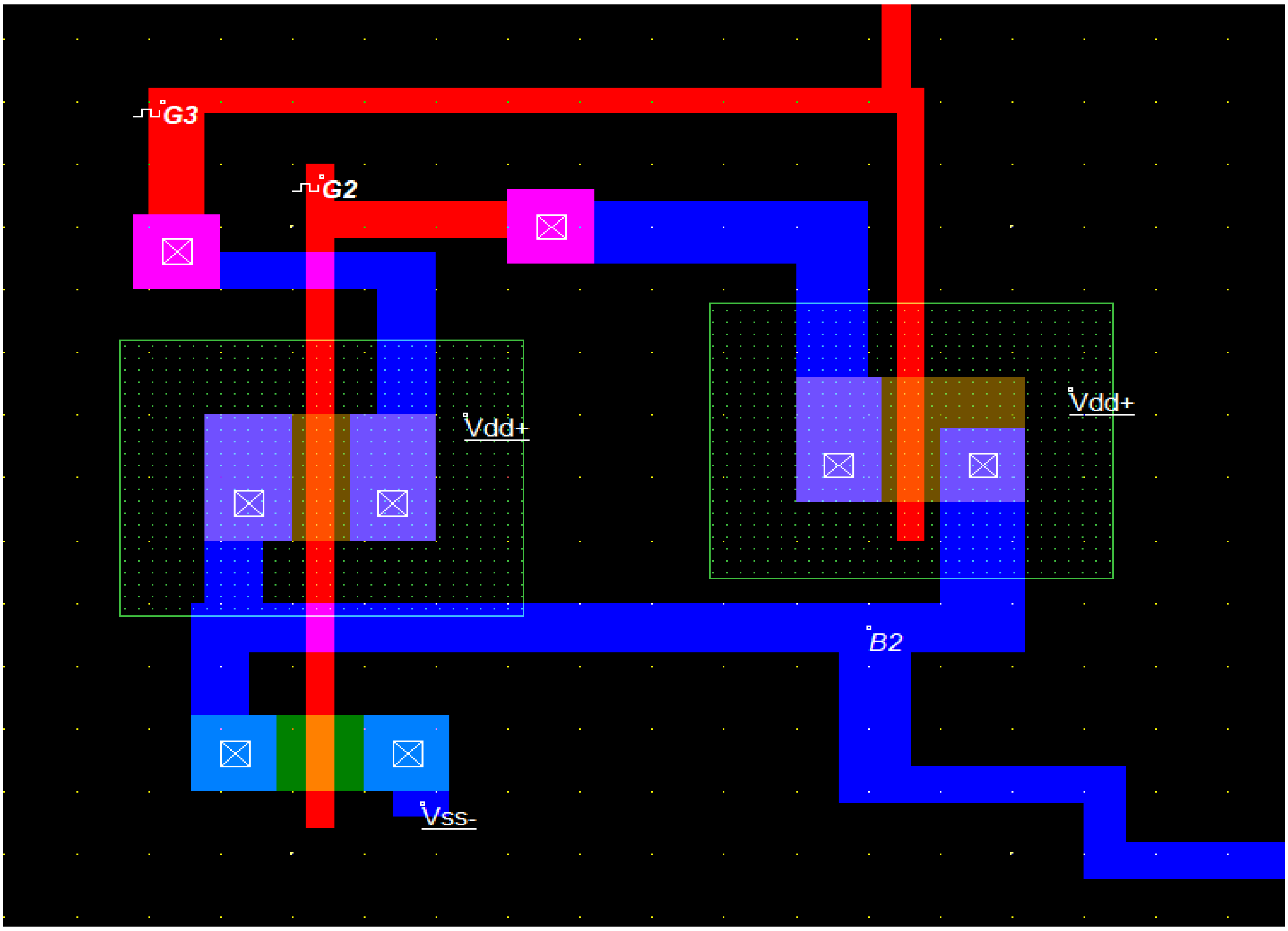
Truth table(for 4-bit):

Gray Code Input				Binary Code Output			
G3	G2	G1	G0	B3	B2	B1	B0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	1	0	0	1	0
0	0	1	0	0	0	1	1
0	1	1	0	0	1	0	0
0	1	1	1	0	1	0	1
0	1	0	1	0	1	1	0
0	1	0	0	0	1	1	1
1	1	0	0	1	0	0	0
1	1	0	1	1	0	0	1
1	1	1	1	1	0	1	0
1	1	1	0	1	0	1	1
1	0	1	0	1	1	0	0
1	0	1	1	1	1	0	1
1	0	0	1	1	1	1	0
1	0	0	0	1	1	1	1

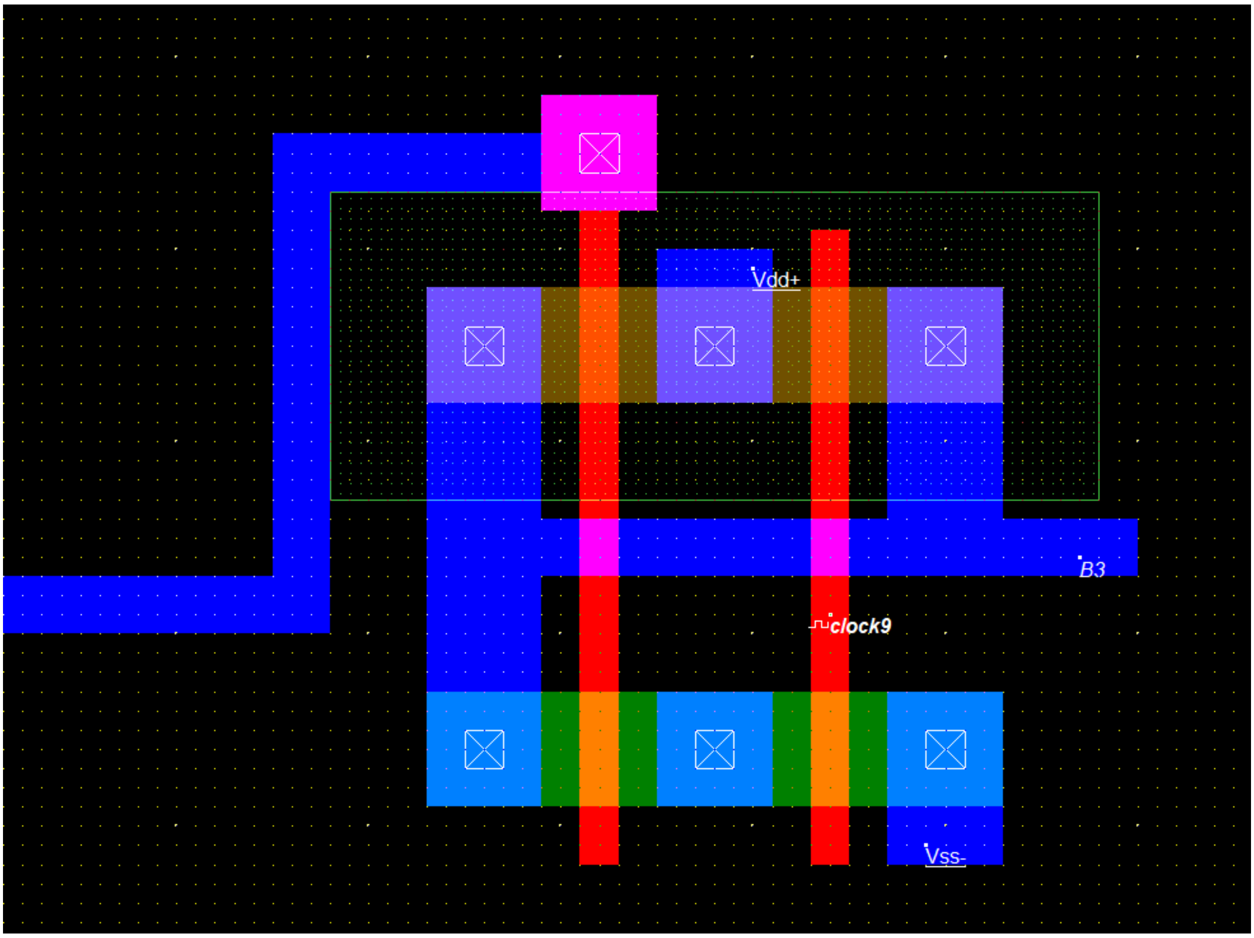
Table1

Xor gate

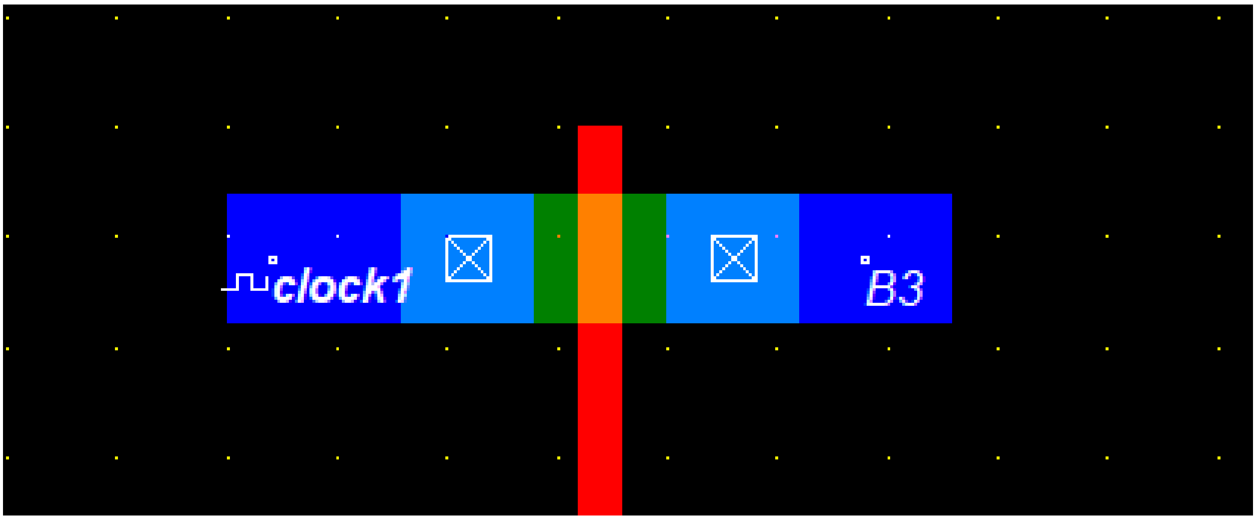
Optimized xor gate



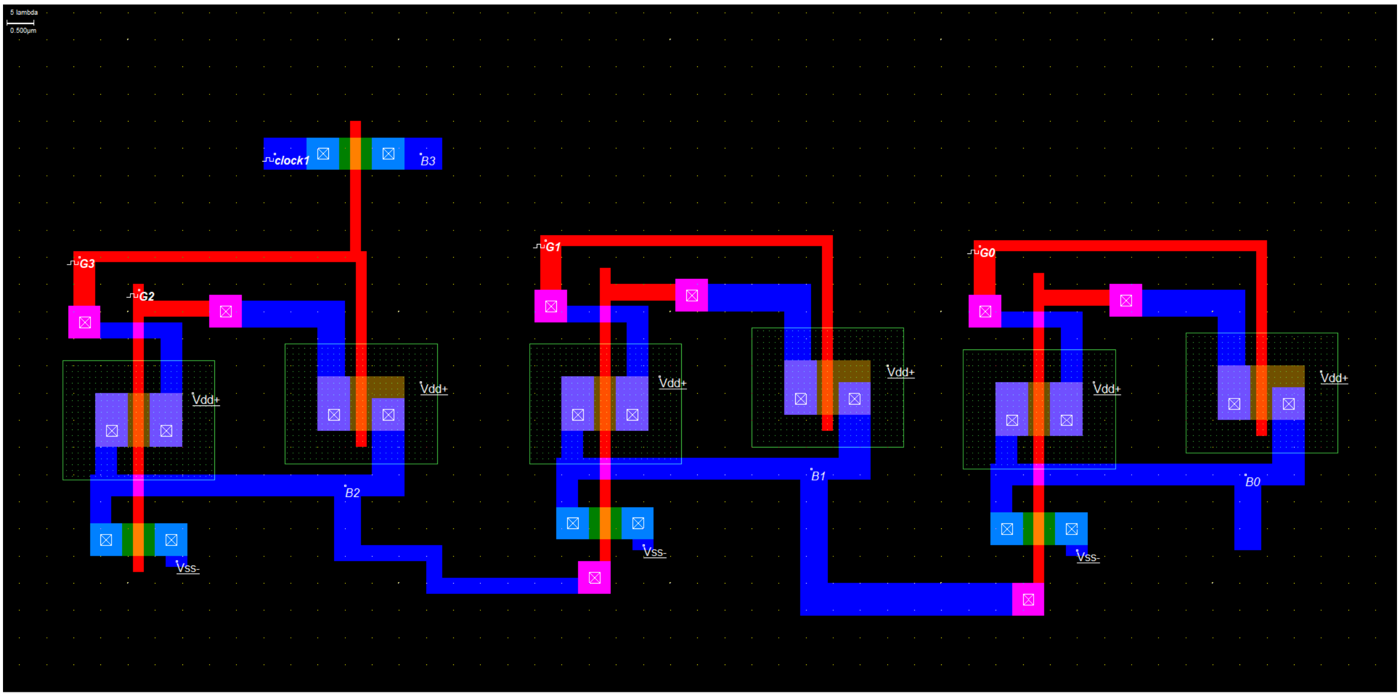
And gate



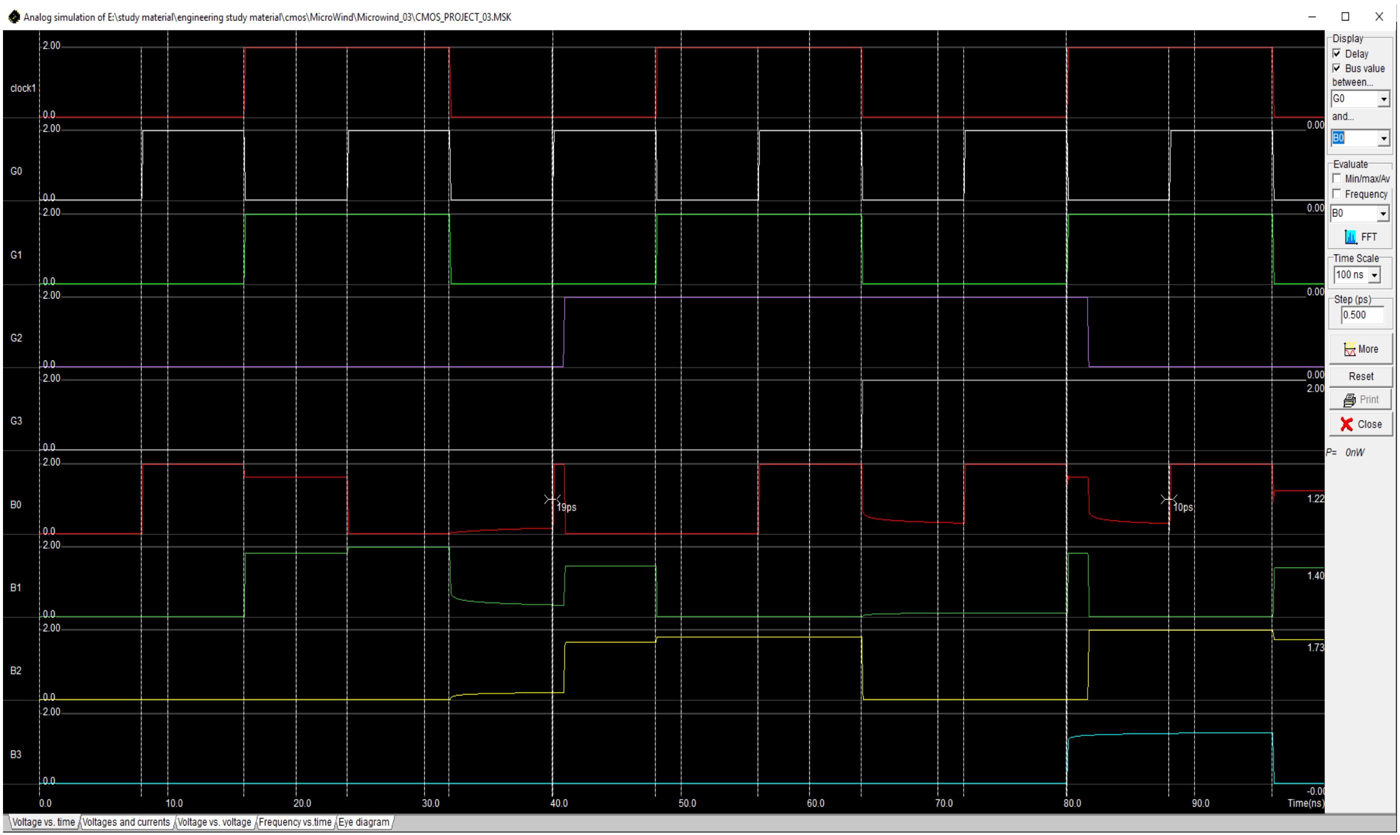
Optimized and gate



Whole circuit:



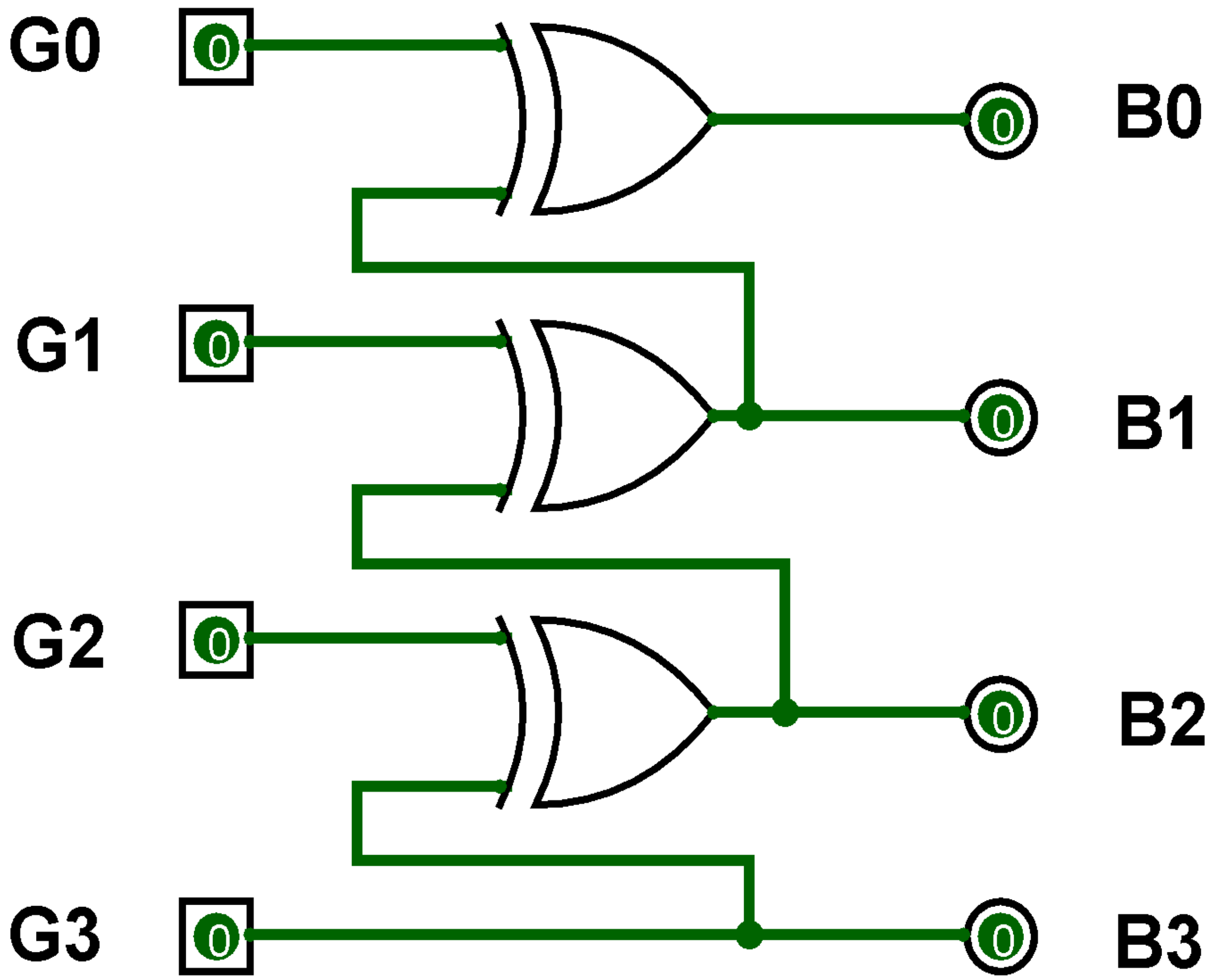
Microwind Output:



Binary code is a number system that uses two symbols, typically 0 and 1. The decimal number system we use in everyday life is a base-10 system, which uses ten symbols (0 through 9). In contrast, the binary system is a base-2 system, which uses only two symbols (0 and 1).

A gray code is a binary code where two successive values differ in only one bit. The advantage of using gray code is that it eliminates the problem of misreads due to bit transitions in binary codes. Gray code is commonly used in applications where accurate position or direction sensing is required, such as rotary encoders.

A gray to binary converter is a device that converts a gray code input into its binary equivalent output. The process of converting gray code to binary involves performing an exclusive-OR (XOR) operation on each bit of the gray code with the bit to its left, starting with the most significant bit (MSB). The MSB of the binary code is the same as the MSB of the gray code.



```
** Gray to Binary converter using pass transistor logic



.subckt inverter 1 2 3

mp 2 1 3 3 pmod w=100u l=1u

mn 2 1 0 0 nmod w=40u l= 1u

.model pmod pmos level =54 version = 4.7

.model nmod nmos level =54 version = 4.7

.ends


.subckt pass_and 1 2 3 4

m1 1 2 4 4 nmod w =40u  l=1u


m2 2 3 4 4 nmod w =40u  l=1u

.model nmod nmos level =54 version = 4.7

.ends
```

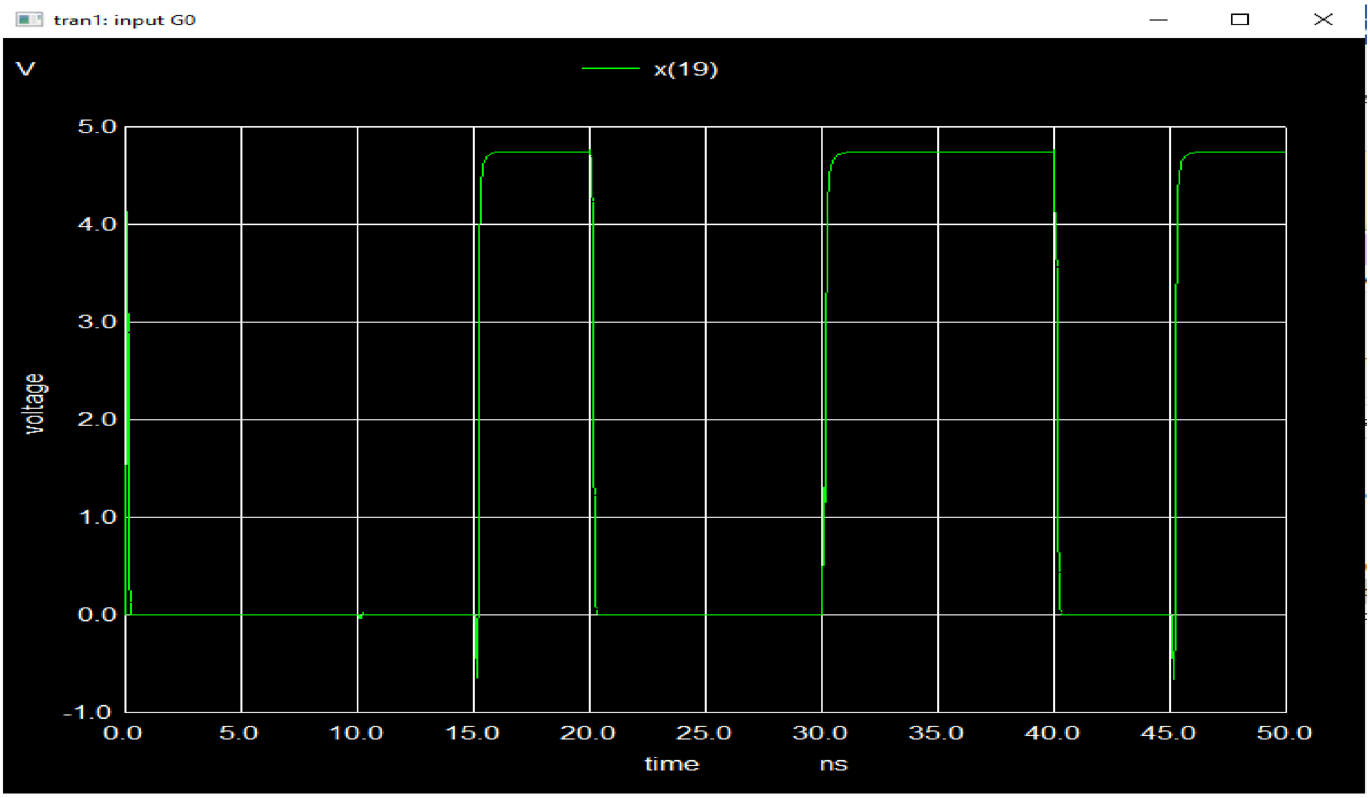
```
.subckt  pass_xor 1 2 3 4 5

m1 1 4 5 5 nmod w =40u  l=1u

m2 3 2 5 5 nmod w =40u  l=1u

.model nmod nmos level =54 version = 4.7

.ends



vdd 1 0 dc 5v

va 11 0 pulse(0 5 0 0 0 20ns 40ns)

vb 12 0 pulse(0 5 0 0 0 15ns 30ns)

vc 13 0 pulse(0 5 0 0 0 10ns 20ns)

vd 14 0 pulse(0 5 0 0 0 5ns 10ns)


xa 11 15 1 inverter

xb 12 16 1 inverter

xc 13 17 1 inverter
```

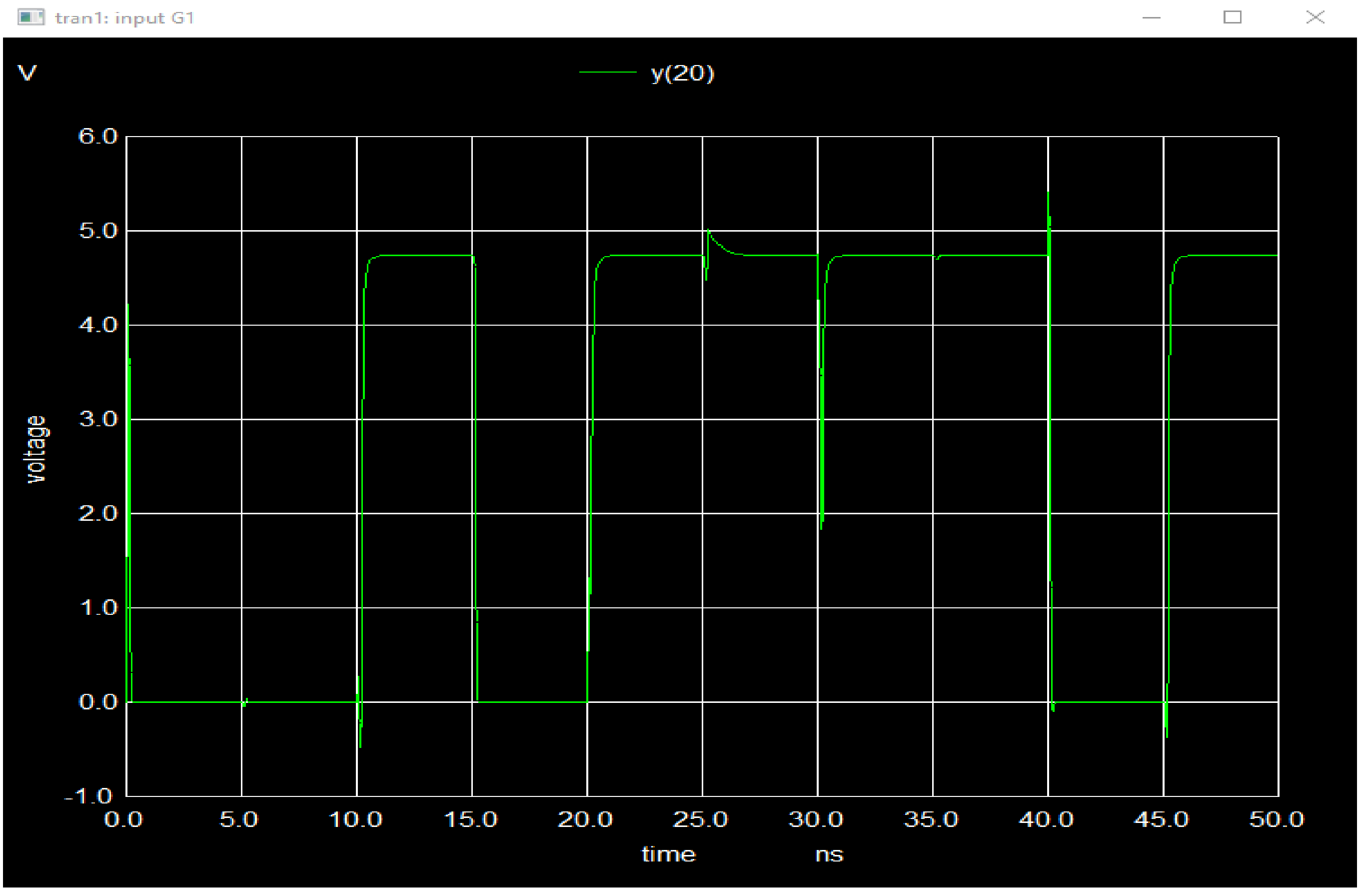
```
 xd 14 18 1 inverter

xa_xor_b 11 12 15 16 19  pass_xor

xb_xor_c 12 13 16 17 20  pass_xor

xc_xor_d 13 14 17 18 21  pass_xor

xd_and_d 14 14 18 22 pass_and

.tran 0.1ns 50ns
.control
run

plot X(19)  xlabel 'time' ylabel 'voltage' title 'input G0'

plot Y(20)  xlabel 'time' ylabel 'voltage' title 'input G1'

plot Z(21)  xlabel 'time' ylabel 'voltage' title 'input G2'

plot W(22)  xlabel 'time' ylabel 'voltage' title 'input G3'

set color0 = 'white'
set color1 = 'black'
set xbrushwidth = 2
```

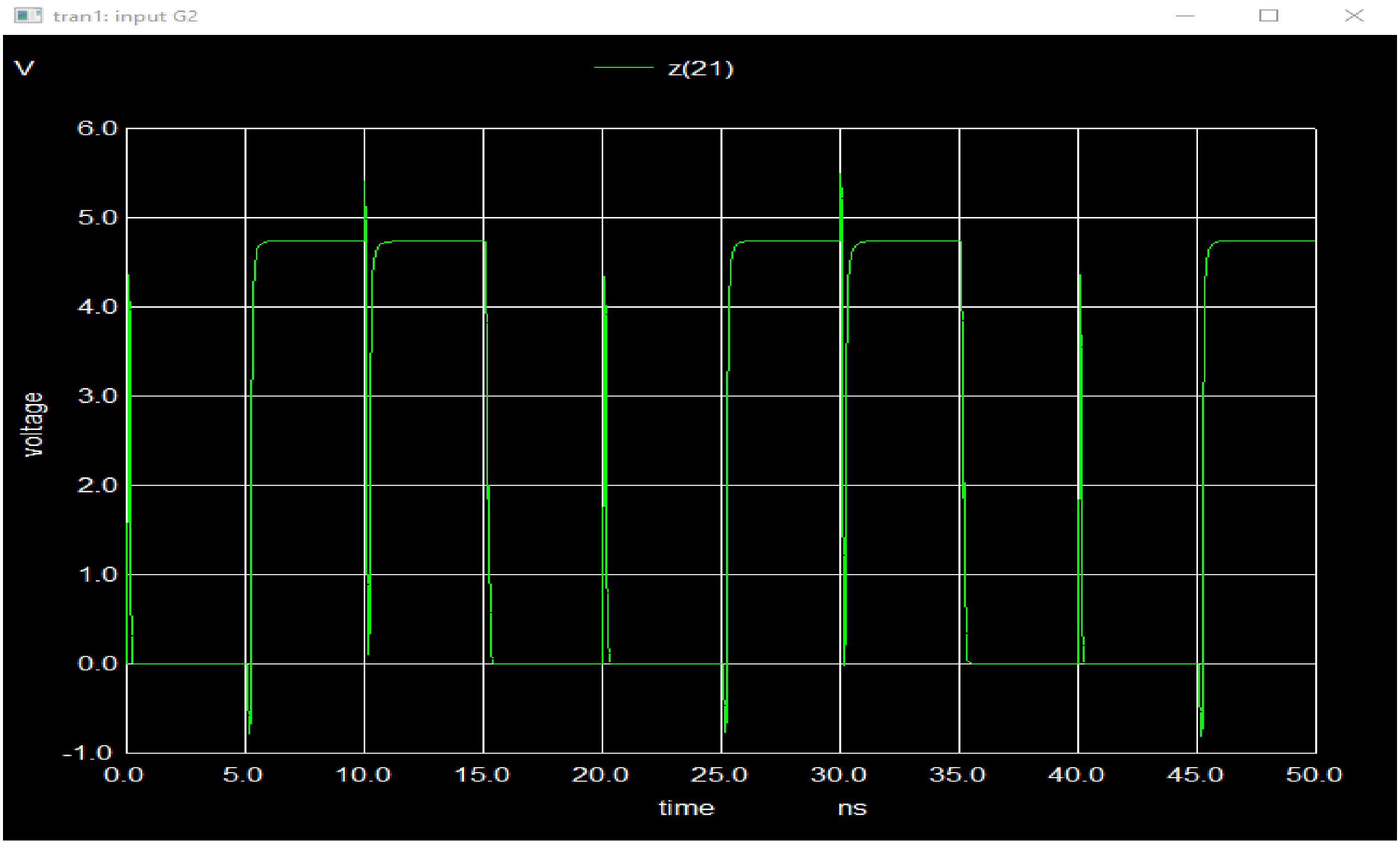
```
plot A(11)  xlabel 'time' ylabel 'voltage levels' title 'Output B0'

plot B(12)   xlabel 'time' ylabel 'voltage levels' title 'Output B1'

plot C(13)   xlabel 'time' ylabel 'voltage levels' title 'Output B2'

plot D(14)   xlabel 'time' ylabel 'voltage levels' title 'Output B3'


.endc
.end
```

RESULTS:

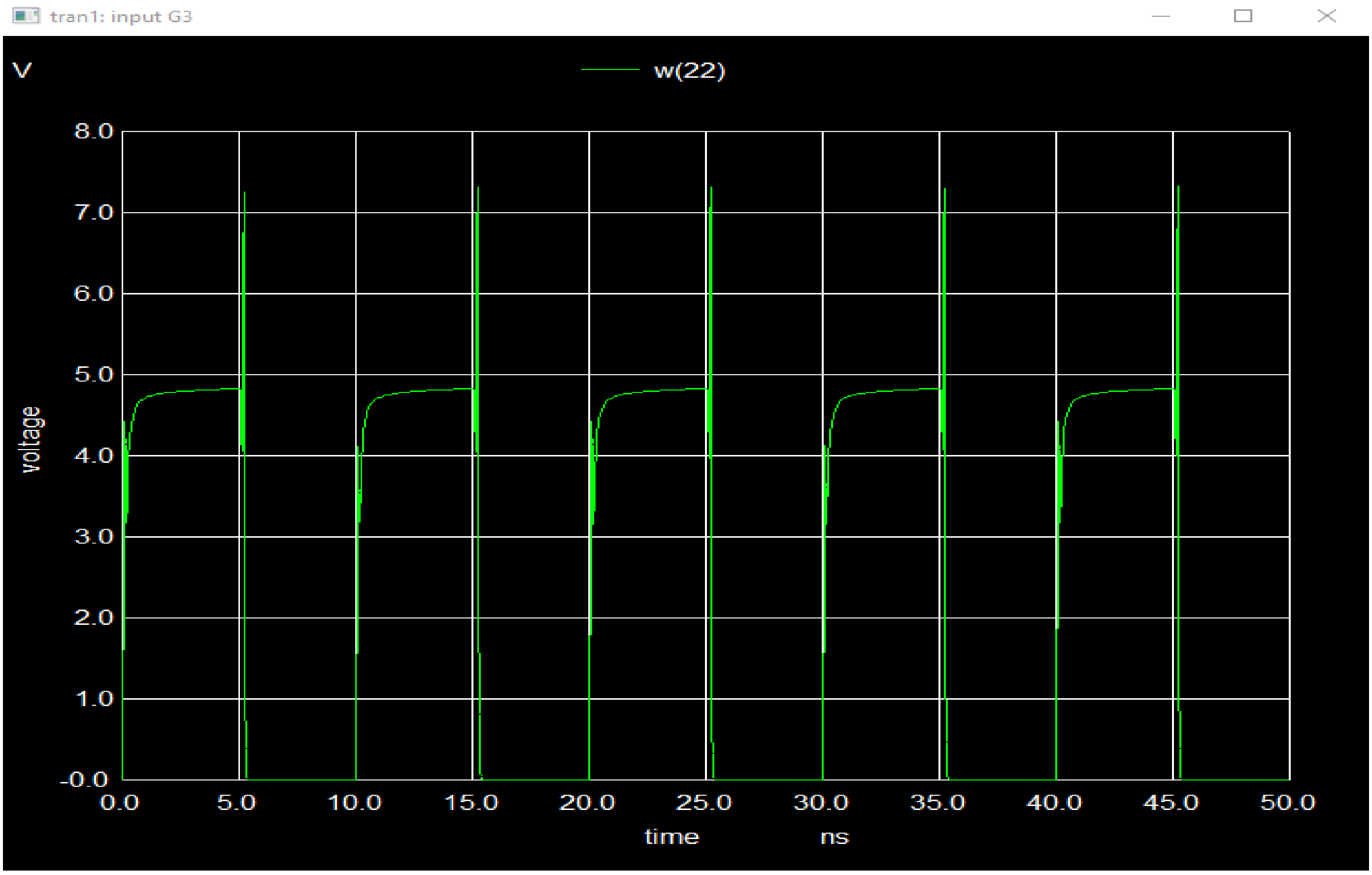
NGSPICE OUTPUT:





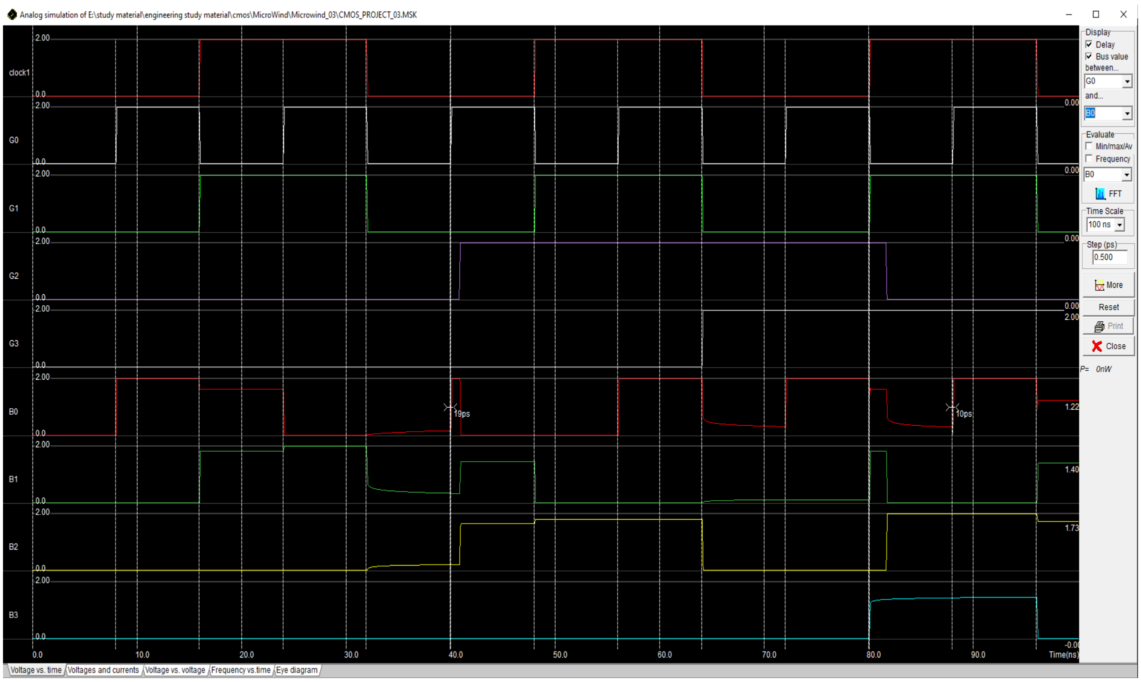


tran1: input G2
V
z(21)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
voltage
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
time
ns



tran1: input G3
V
w(22)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
-0.0
voltage
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
time
ns

<u>MICROWIND LAYOUT OUTPUT(MOD-8)</u>:



CONCLUSION :

Hence we have done the all the activities to create a gray to binary converter

THANK YOU!.