Gebze Technical University

Computer Engineering Departman

CSE 436 Digital Integrated Circuit

Homework #2

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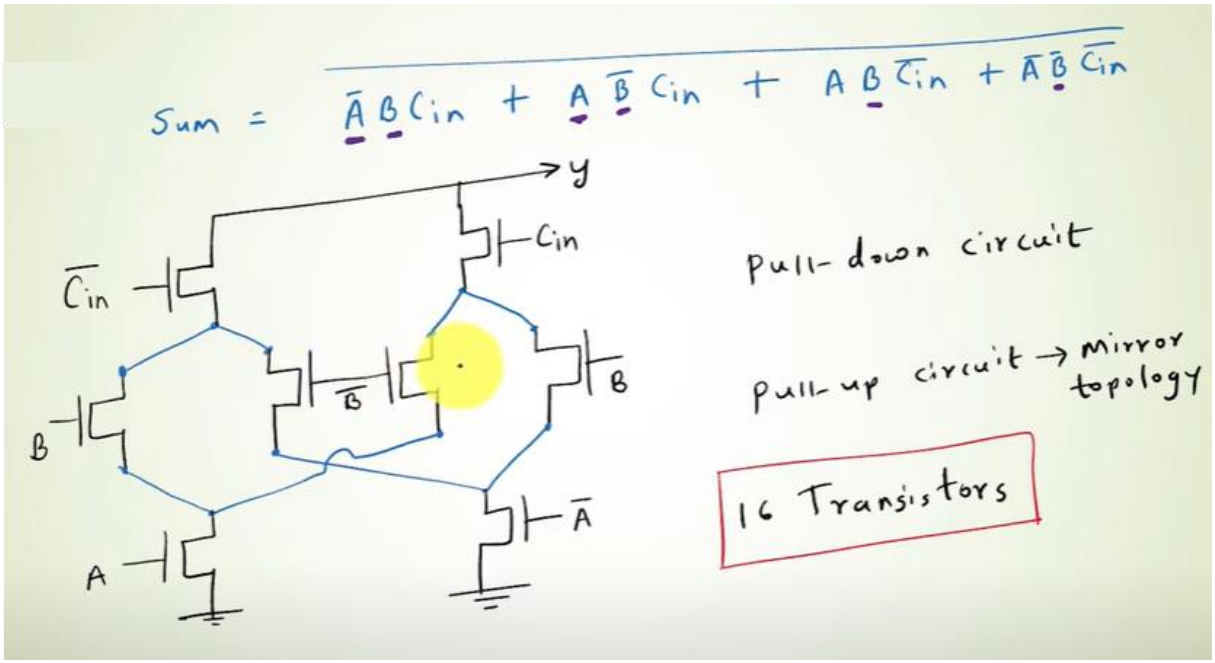
Note: 1 bit adder works without errors. Full adder makes a total of mistakes.

1 Bit Adder Truth Table

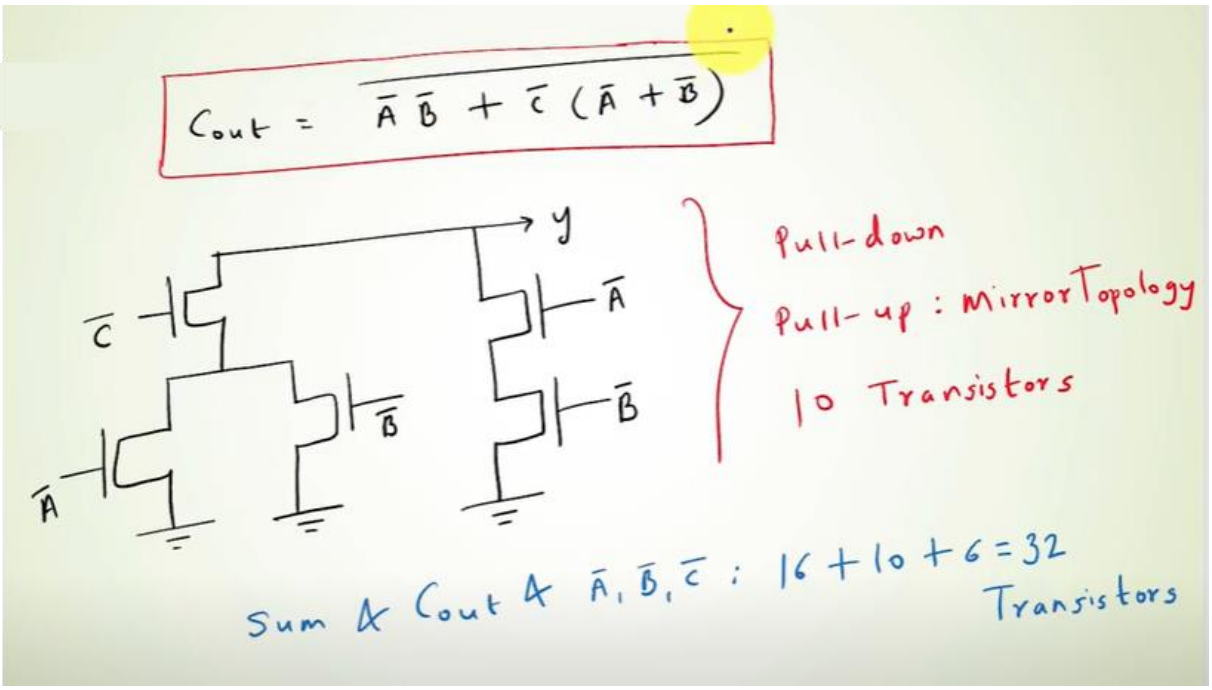
A	B	Cin	Sum	Cout
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Transistor Desing

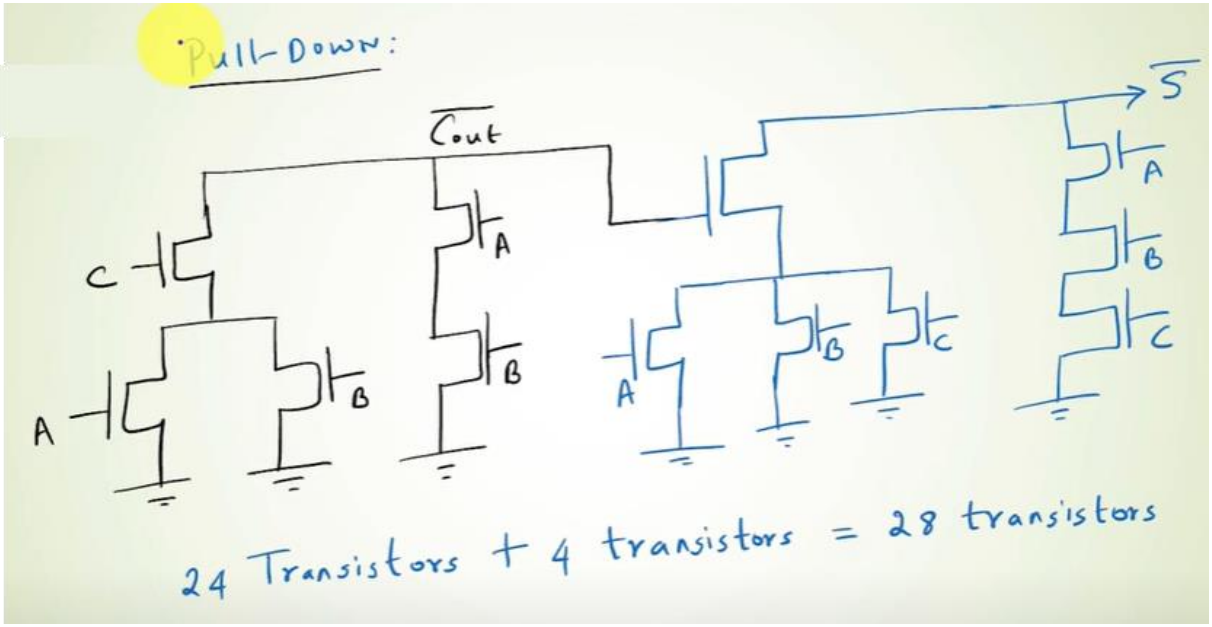
Sum=ABCin+ABCin+ABCin+ABCin



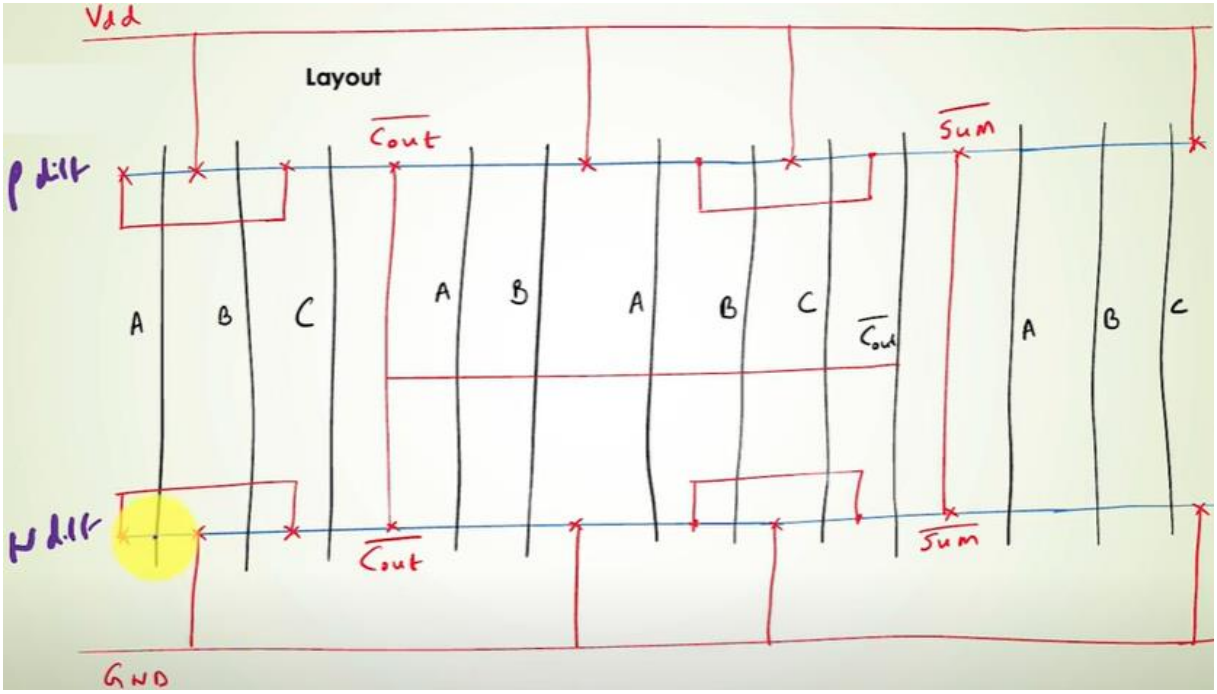
Cout=AB+BCin+ACin



Transistors Diagram(Pull Down Network)

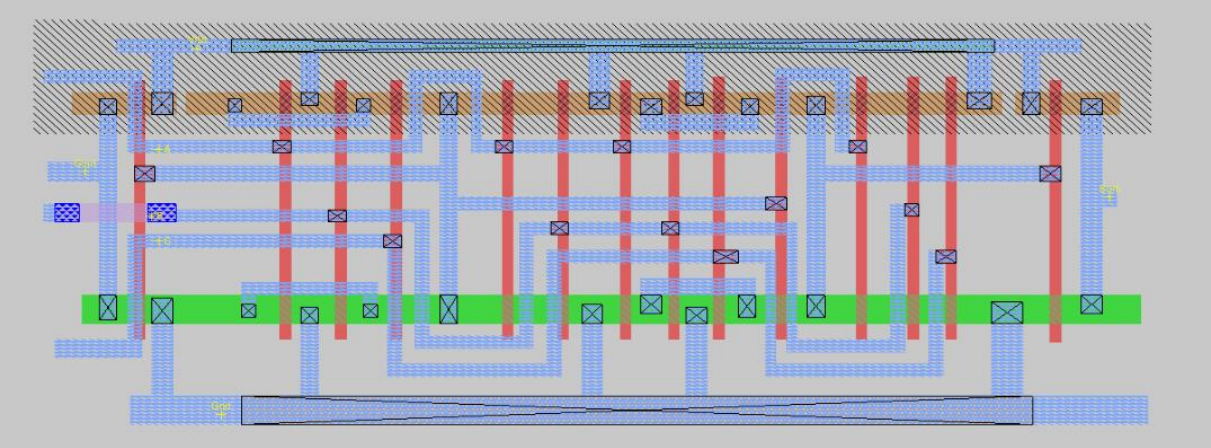


Stick Diagram

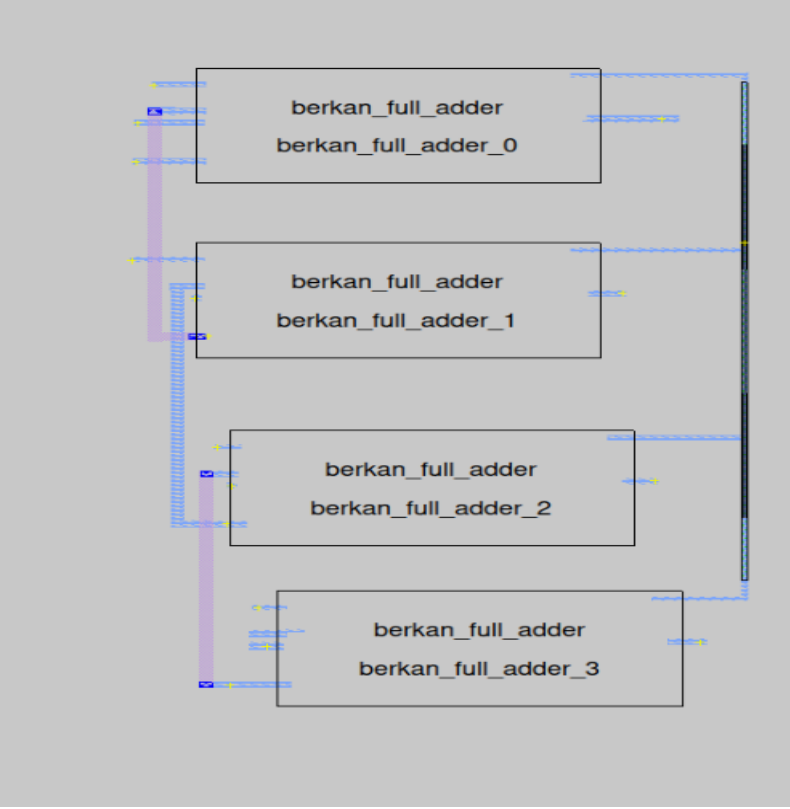


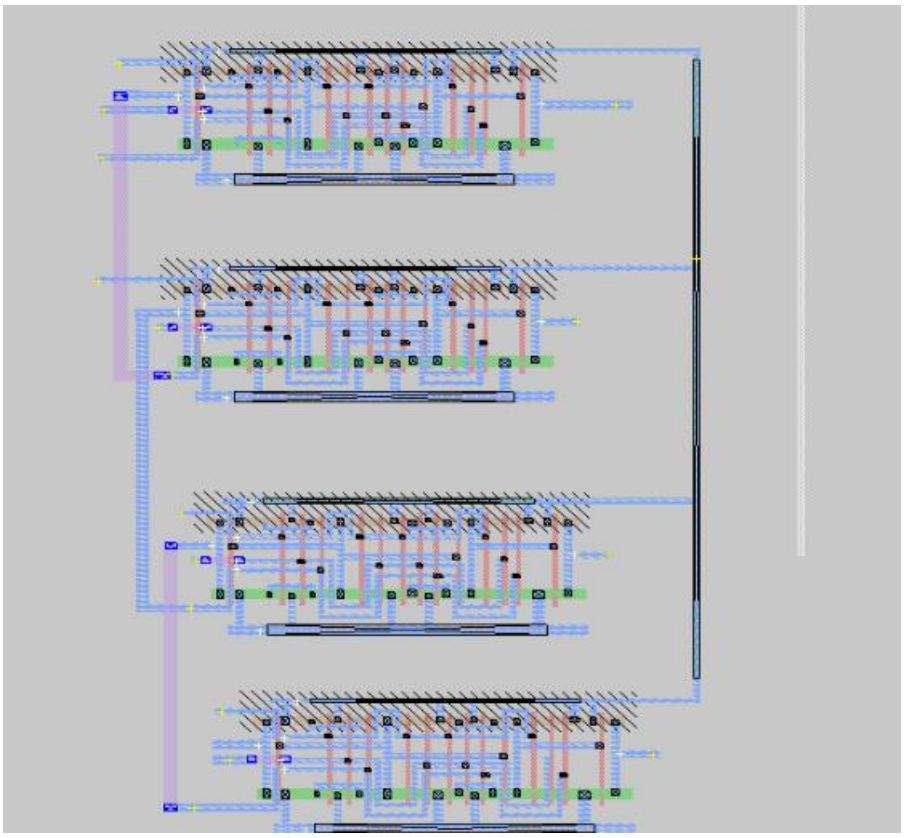
Magic Desing

1 Bit Full Adder



4 Bit Full Adder





Test Case

1 Bit Full Adder

A B C | Sum Cout

0 0 0 | 0 0

```
Initial Transient Solution
--------------------------

Node                                   Voltage
----                                   -------
a                                            0
vdd                                          5
b                                            0
sum                                3.23643e-09
c                                            0
cout                               3.23643e-09
vc#branch                                    0
vb#branch                                    0
va#branch                                    0
vdd#branch                        -4.72843e-11
```

```
VDD VDD 0 DC 5


VA A 0 0
VB B 0 0
VC C 0 0


.tran  1NS 200NS
.controll
run
plot V(A) V(B) V(C) V(Sum) V(Cout)

.endc
.end
```

A B C | Sum Cout

1 0 0 | 1 0

Node	Voltage
a	5
vdd	5
b	0
sum	5
c	0
cout	3.23643e-09
vc#branch	0
vb#branch	0
va#branch	0
vdd#branch	-3.86721e-11

```
VDD VDD 0 DC 5


VA A 0 5
VB B 0 0
VC C 0 0


.tran  1NS 200NS
.controll
run
plot V(A) V(B) V(C) V(Sum) V(Cout)

.endc
.end
```

A B C | Sum Cout

1 1 0 | 0 1

Initial Transient Solution

Node	Voltage
a	5
vdd	5
b	5
sum	3.23643e-09
c	0
cout	5
vc#branch	0
vb#branch	0
va#branch	0
vdd#branch	-6.0226e-11

```
VDD VDD 0 DC 5


VA A 0 5
VB B 0 5
VC C 0 0


.tran  1NS 200NS
.controll
run
plot V(A) V(B) V(C) V(Sum) V(Cout)

.endc
.end
```

A B C | Sum Cout

1 1 1 | 1 1

```
Initial Transient Solution
--------------------------

Node                                   Voltage
----                                   -------
a                                            5
vdd                                          5
b                                            5
sum                                          5
c                                            5
cout                                         5
vc#branch                                    0
vb#branch                                    0
va#branch                                    0
vdd#branch                       -4.72971e-11
```

```
VDD VDD 0 DC 5


VA A 0 5
VB B 0 5
VC C 0 5


.tran  1NS 200NS
.controll
run
plot V(A) V(B) V(C) V(Sum) V(Cout)

.endc
.end
```

4 Bit Full Adder

A4 A3 A2 A1 + B4 B3 B2 B1 = Sum4 Sum3 Sum2 Sum1

0000 + 0000 = 0000

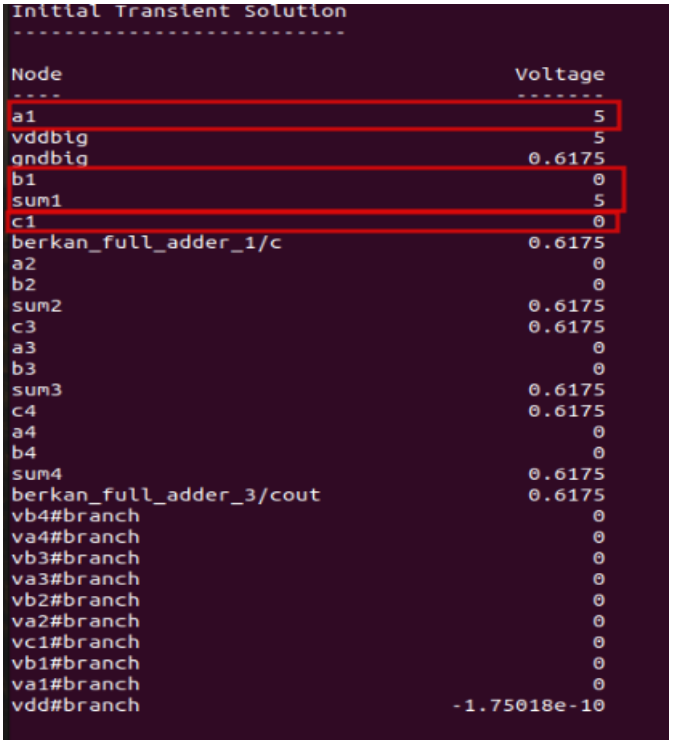
Initial Transient Solution

Node	Voltage
a1	0
vddbig	5
gndbig	0.6175
b1	0
sum1	0.6175
c1	0
berkan_full_adder_1/c	0.6175
a2	0
b2	0
sum2	0.6175
c3	0.6175
a3	0
b3	0
sum3	0.6175
c4	0.6175
a4	0
b4	0
sum4	0.6175
berkan_full_adder_3/cout	0.6175
vb4#branch	0
va4#branch	0
vb3#branch	0
va3#branch	0
vb2#branch	0
va2#branch	0
vc1#branch	0
vb1#branch	0
va1#branch	0
vdd#branch	-1.84255e-10

```
VDD Vddbig 0 DC 5


VA1 A1 0 0
VB1 B1 0 0
VC1 C1 0 0

VA2 A2 0 0
VB2 B2 0 0

VA3 A3 0 0
VB3 B3 0 0

VA4 A4 0 0
VB4 B4 0 0

.tran  1NS 200NS
.controll
run
plot V(A1) V(B1) V(A2) V(B2) V(A3) V(B3) V(A4) V(B4) V(C1) V(Sum1) V(Sum2) V(Sum3)  V(Sum4)

.endc
.end
```

A4 A3 A2 A1 + B4 B3 B2 B1 = Sum4 Sum3 Sum2 Sum1

0001 + 0000 = 0001



Initial Transient Solution

Node	Voltage
a1	5
vddbig	5
gndbig	0.6175
b1	0
sum1	5
c1	0
berkan_full_adder_1/c	0.6175
a2	0
b2	0
sum2	0.6175
c3	0.6175
a3	0
b3	0
sum3	0.6175
c4	0.6175
a4	0
b4	0
sum4	0.6175
berkan_full_adder_3/cout	0.6175
vb4#branch	0
va4#branch	0
vb3#branch	0
va3#branch	0
vb2#branch	0
va2#branch	0
vc1#branch	0
vb1#branch	0
va1#branch	0
vdd#branch	-1.75018e-10

A4 A3 A2 A1 + B4 B3 B2 B1 = Sum4 Sum3 Sum2 Sum1

0011 + 0000 = 0011

```
Initial Transient Solution
--------------------------

Node                                   Voltage
----                                   -------
a1                                           5
vddbig                                       5
gndbig                                  0.6175
b1                                           0
sum1                                         5
c1                                           0
berkan_full_adder_1/c                   0.6175
a2                                           5
b2                                           0
sum2                                         5
c3                                      0.6175
a3                                           0
b3                                           0
sum3                                    0.6175
c4                                      0.6175
a4                                           0
b4                                           0
sum4                                    0.6175
berkan_full_adder_3/cout                0.6175
vb4#branch                                   0
va4#branch                                   0
vb3#branch                                   0
va3#branch                                   0
vb2#branch                                   0
va2#branch                                   0
vc1#branch                                   0
vb1#branch                                   0
va1#branch                                   0
vdd#branch                          -1.65782e-10
```

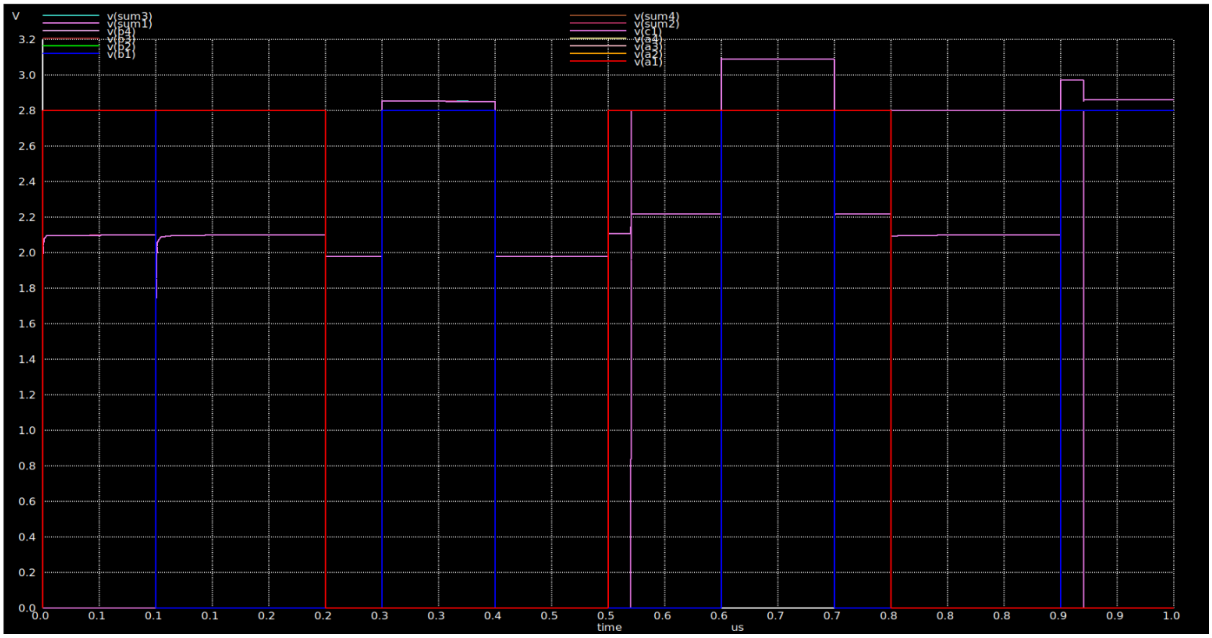
A4 A3 A2 A1 + B4 B3 B2 B1 = Sum4 Sum3 Sum2 Sum1

0011 + 0011 = 0110

! It produces wrong results

```
Initial Transient Solution
--------------------------

Node                                   Voltage
----                                   -------
a1                                         2.5
vddbig                                     2.5
berkan_full_adder_0/gnd                0.531207
b1                                         2.5
sum1                                   0.531207
c1                                            0
berkan_full_adder_1/c                      2.5
a2                                         2.5
berkan_full_adder_1/gnd                0.500549
b2                                         2.5
sum2                                       2.5
c3                                         2.5
a3                                            0
berkan_full_adder_2/gnd                 1.79957
b3                                            0
sum3                                    2.49994
c4                                      1.79957
a4                                            0
berkan_full_adder_3/gnd                 1.09936
b4                                            0
sum4                                       2.5
berkan_full_adder_3/cout                1.09936
vb4#branch                                    0
va4#branch                                    0
vb3#branch                                    0
va3#branch                                    0
vb2#branch                                    0
va2#branch                                    0
vc1#branch                                    0
vb1#branch                                    0
va1#branch                                    0
vdd#branch                          -1.22397e-10
```

Meaningless Plot Occurred



Resources

https://www.youtube.com/watch?v=N3H-QsGNIiI&t=1317s