Lab Report - 04

Course No: 206

Course Title: Digital Logic Design

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Lab Report → 04

Name of Experiment :

Construct and test various adders and sub-tractor circuit.

Equipment :

1: 2 input AND Gates
2. 3 input AND Gates
3. 2 input OR Gates
4. 4 input OR Gates
5. X-OR Gates
6. Not Gates
7. 3 input OR Gates

Description:

An adders is a digital circuit that performs addition of numbers. In many computers and others kinds of processors adders are used in the arithmetic Logic units or other signed numbers representations require more logic around the basic adders. There are two types of adders: ① Half adders
② full adders.

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Half adder:- The half adder circuit has two inputs (x and y) which add two input digit and generates a carry and a sum. Half adder circuit doesn't consider the previous carry.

Full adder:- The full adder circuit has three input (x, y and z) where z is a previous carry and (x and y) are a literal. The full adder generate a carry and sum. It also consider the previous carry.

Half Adders

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This is the truth table of Half adders

x	y	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

result

$S = x'y + xy' = x \oplus y$

$C = xy$

This is the truth table of Full adders

x	y	z	C	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

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K-map of carrcay

x \ yz	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$C = xz + xy + yz$

K-map of Sum

x \ yz	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$S = x'y'z + x'yz' + xy'z' + xyz$

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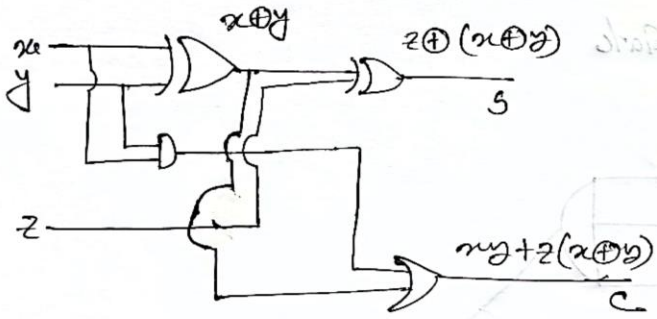
Circuit of full adder using half adder:

Equipment

1. 2 AND Gate
2. 2 XOR Gate
3. OR Gate



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Simplification Full adders using half adders

$S = x'y'z + x'yz' + xy'z' + xyz$

$= z'(x'y + xy') + z(x'y' + xy)$

$= z'(x \oplus y) + z(x \oplus y)'$

$= z \oplus (x \oplus y)$ [Combine two half adders]

$C = xy + yz + xz$

$= xy + yz(x + x') + xz$

$= xy + xyz + x'yz + xz$

$= xy + x'yz + xyz + xz$

$= xy + x'yz + xz(y + 1)$

$= xy + x'yz + xz \cdot 1$

$= xy + x'yz + xz(y + y')$

$= xy + x'yz + xyz + xy'z$

$= xy(1+z) + x'yz + xy'z$

$= xy + x'yz + xy'z$

$= xy + z(x'y + xy')$

$= xy + z(x \oplus y)$ [combine two half adders]

So, we can say, Full adder make with two half adders.

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Full adder using Basic Gates

Equipment :

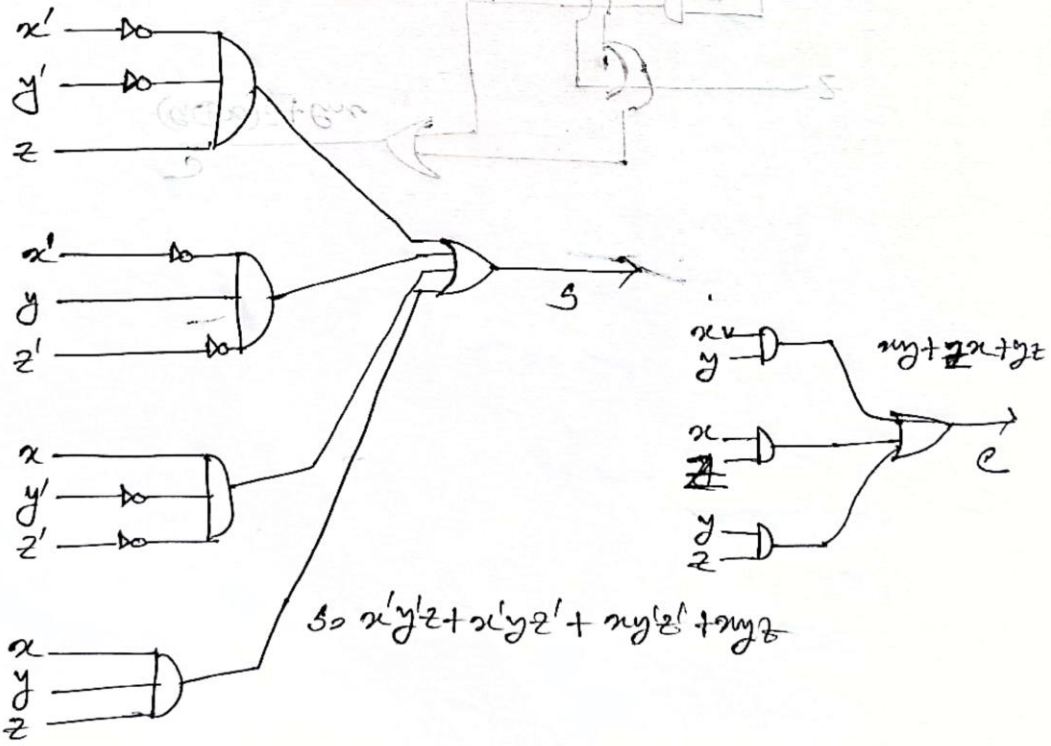
i) 3 input AND Gate

ii) 3 input OR Gate

iii) 4 input OR Gate

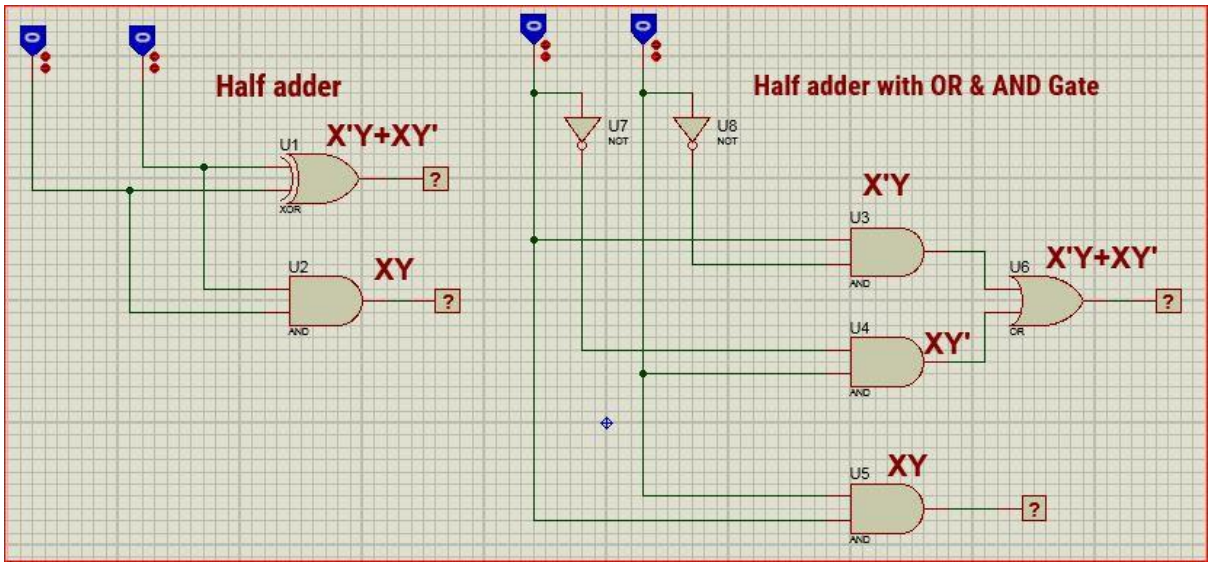
iv) 2 input AND Gate

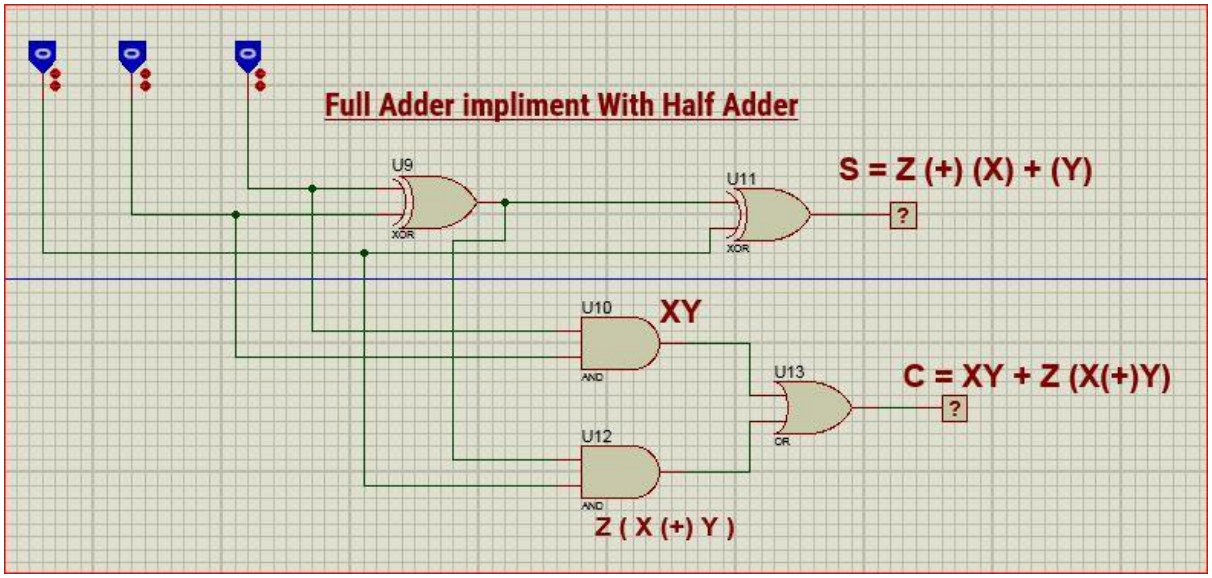
v) Not Gate

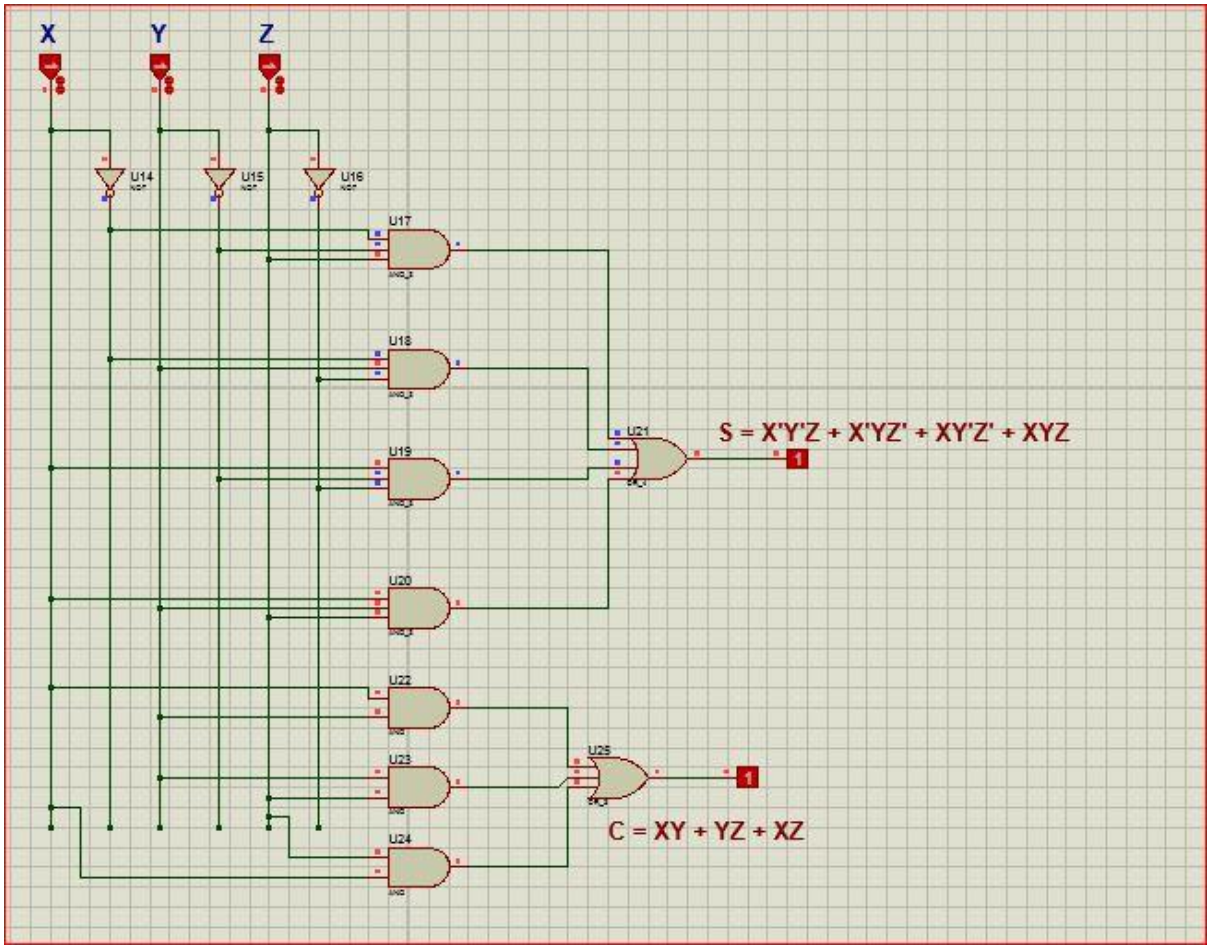


$S = x'y'z + x'yz' + xy'z' + xyz$

$C = xy + yz + zx$


Half adder
X'Y+XY'
U1
XOR
?
U2
XY
AND
?
Half adder with OR & AND Gate
U7
NOT
U8
NOT
X'Y
U3
AND
U6
X'Y+XY'
OR
?
U4
XY'
AND
U5
XY
AND
?


Full Adder impliment With Half Adder
U9
XOR
U11
S = Z (+) (X) + (Y)
XOR
?
U10
XY
AND
U13
C = XY + Z (X(+)Y)
OR
?
U12
AND
Z (X (+) Y)



Full Adder Using Basic Gates

Subtractor

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Description :

A subtractor logic circuit for calculating the difference between two numbers. The minuend and the numbers to be subtracted.

Half Subtractor :

The half subtractor is also a building block for subtracting two binary numbers. It has two inputs and two outputs. This circuit is used to subtract two single bit binary numbers A and B. The D = Sub and B = borrow are two Output states of half subtractor.

Full Subtractor :

The full subtractor is used to subtract three 1-bit numbers A, B, and C, which are minured subtrahend and borrow respectivly. The full subtractor has three input states and two outputs State. Sub = D and borrow = B

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Half Subtractor

A	B	Bn	D
0	0	0	0
0	1	1	1
1	0	0	1
1	1	0	0

Half Subtractor implement with k-map of Borrow

A \ B	0	1
0	0	1
1	0	0

$B = \bar{A}B$

Half Subtractor implement with k-map of (D)

A \ B	0	1
0	0	1
1	1	0

$D = \bar{A}B + A\bar{B} = A \oplus B$

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Full Subtractor

A	B	C	Bn	D
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	0
1	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

(A, B) → literal

C ⇒ Previous Borrow

K-map for Borrow

A \ BC	00	01	11	10
0	0	1	1	1
1	0	0	1	0

Borrow = $A'C + BC + A'B$

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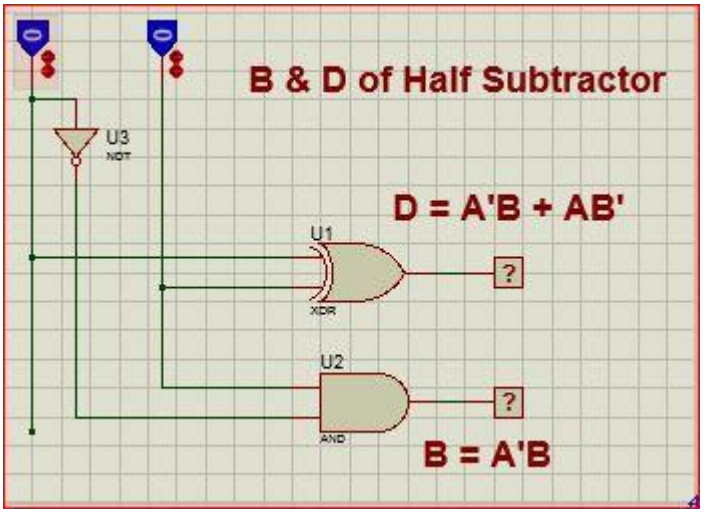
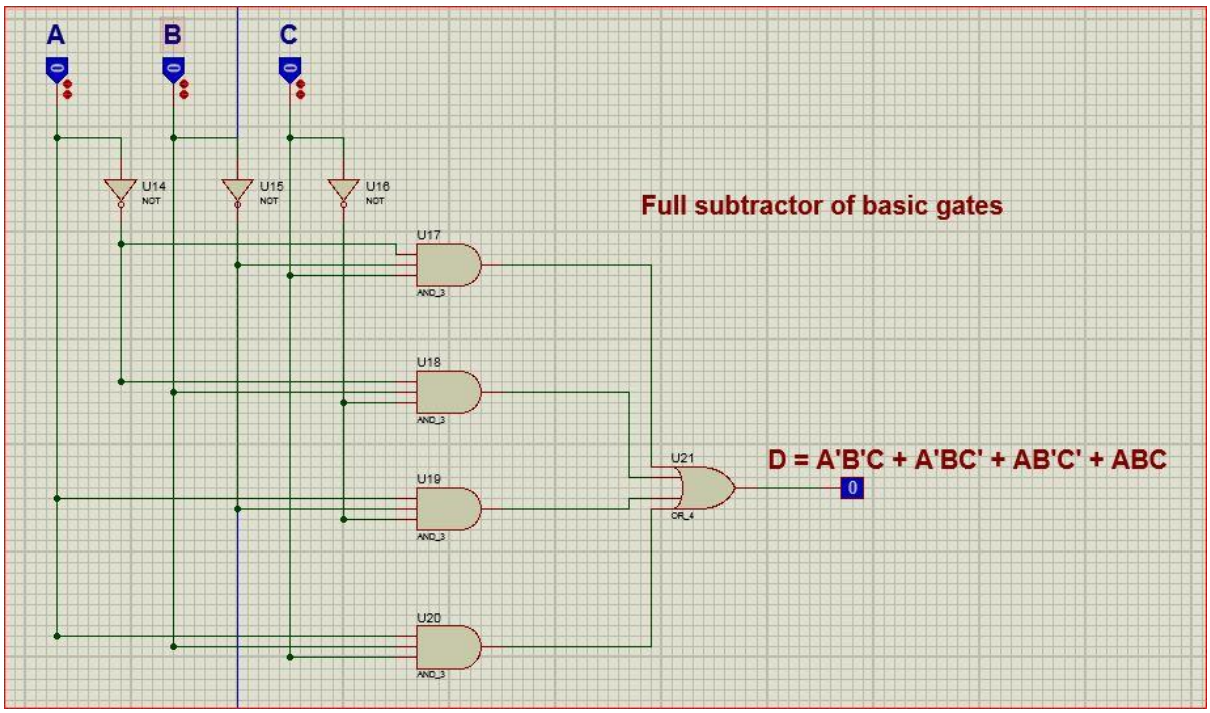
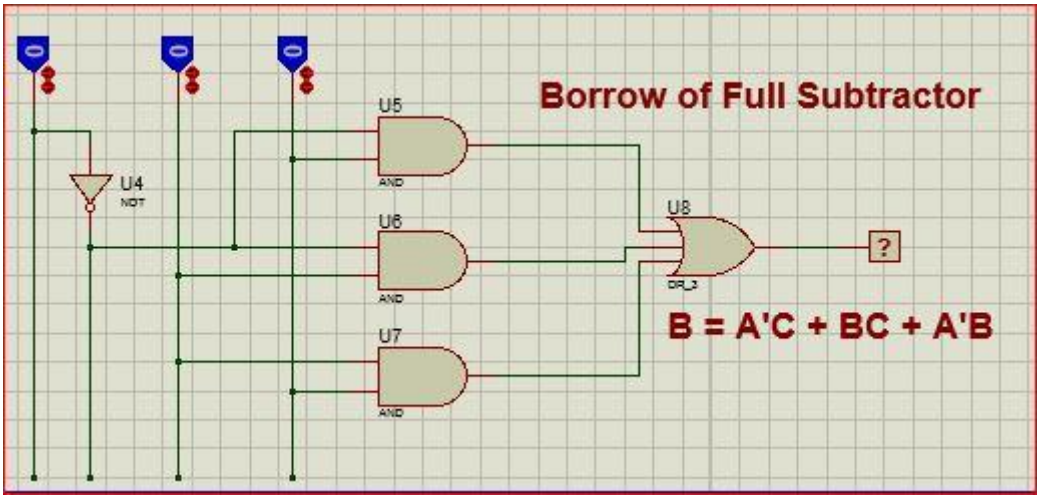
K-map for D = Sub

A \ BC	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$$D = A'B'C + A'BC' + AB'C' + ABC$$


B & D of Half Subtractor
U3
NOT
D = A'B + AB'
U1
XOR
?
U2
AND
?
B = A'B


A
B
C
U14
NOT
U15
NOT
U16
NOT
Full subtractor of basic gates
U17
AND_3
U18
AND_3
U21
D = A'B'C + A'BC' + AB'C' + ABC
OR_4
0
U19
AND_3
U20
AND_3


Borrow of Full Subtractor
U5
AND
U4
NOT
U8
OR_3
?
U6
AND
B = A'C + BC + A'B
U7
AND

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Conclusion:-

1. We have learn't how to implement Sub tractor and Full Subtractor.

2. We also know how to work Half adders and how to get full adders from two half adders.

3. We learn't that, Half adder is an adder which adds two binary digits together, resulting in a sum and carry.

4. We also learn't Half Subtractor is another type of combinational circuit which is used to perform subtraction of two bits.

5. We also know, How to implements Half adder, full adder, and Half Subtractor and full Subtractor desing in protues & software.