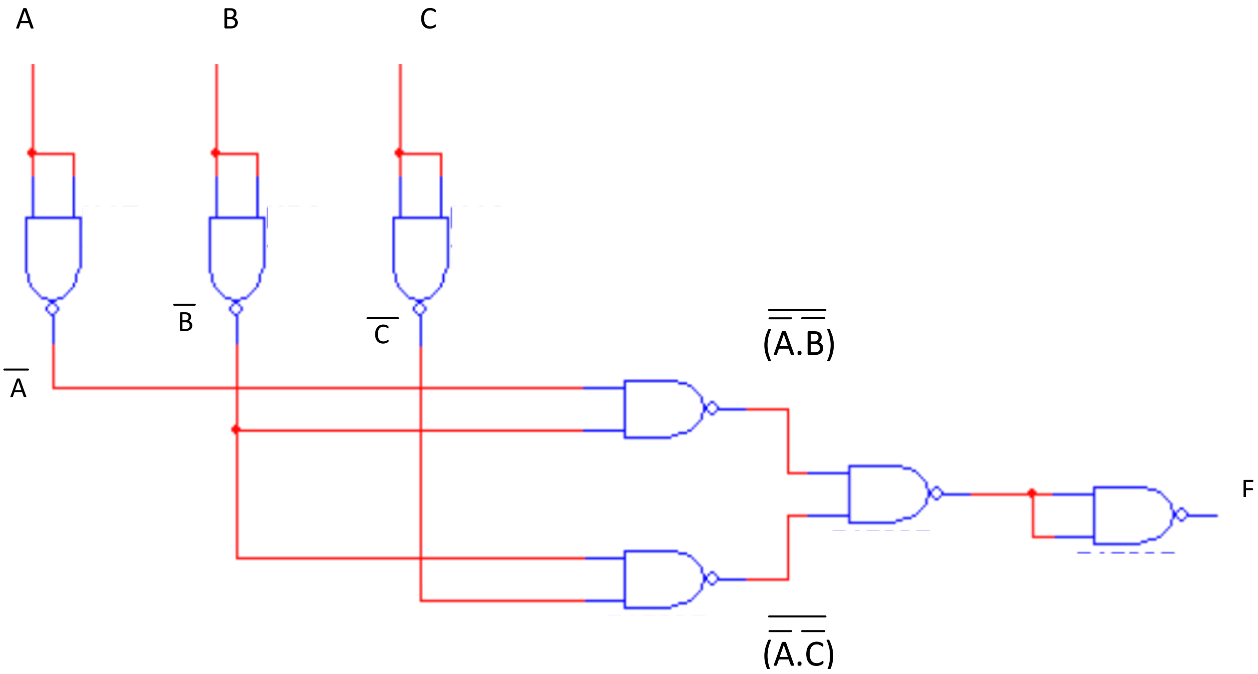
Example 2 / Implement the following expression using NAND gate only ?

$$F = (A+B)(B+C)$$

sol/

$$F = \overline{\overline{(A+B)\,(B+C)}} = \overline{\overline{(A+B)}\;\overline{(B+C)}} = \overline{\bar{A}\,.\,\bar{B} + \bar{B}\,.\,\bar{C}} = \overline{\overline{\overline{(\bar{A}\,.\,\bar{B})}.\overline{(\bar{B}\,.\,\bar{C})}}}$$



Example 3/ Simplify the following expression, and implement using NOR gate only

$A\,\bar{B}\,\bar{C} + A\,C + \bar{A}\,C\,\bar{D}$

$A(C+\bar{C}\,\bar{B}) + \bar{A}\,C\,\bar{D}$

$A(C + \bar{C})\,(C + \bar{B}) + \bar{A}\,C\,\bar{D}$

$A\,C + A\,\bar{B} + \bar{A}\,C\,\bar{D}$

$C(A + \bar{A}\,D) + A\,\bar{B}$

$C\,(A + \bar{A})\,(A + \bar{D}) + A\bar{B}$

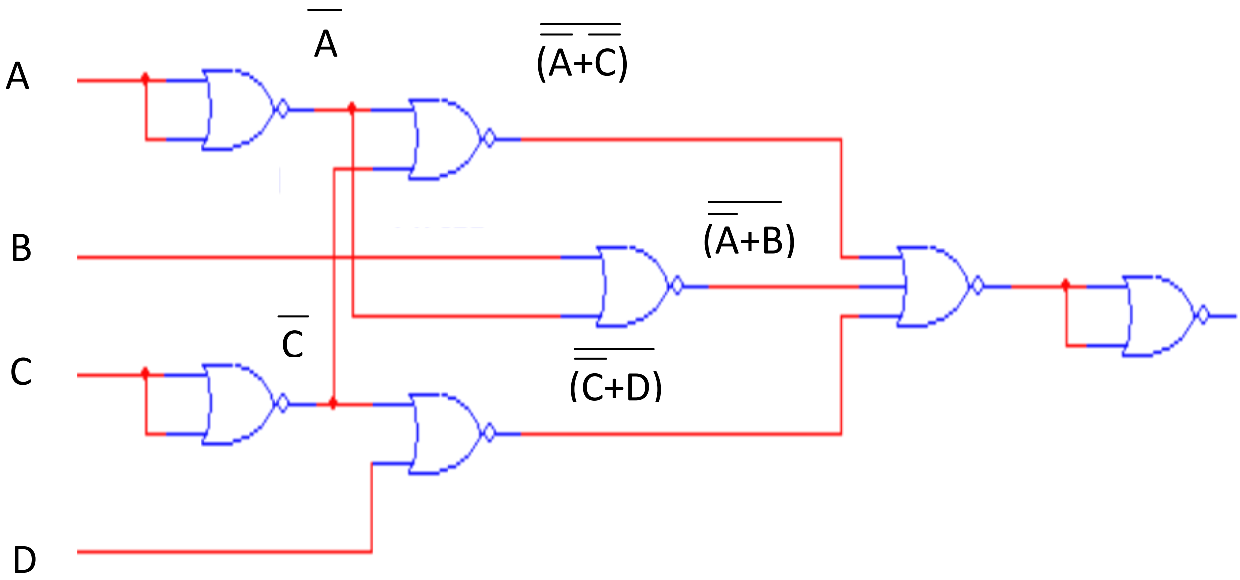
$C(A + \bar{D}) + A\bar{B}$

$A\,C + C\,\bar{D} + A\,\bar{B}$

Example 4/ Implement this Boolean expression using NOR gate using de morgan's theorem

$$\overline{\overline{A\,C + C\,\overline{D} + A\,\overline{B}}} = \overline{\overline{A\,C}\,.\,\overline{C\,\overline{D}}\,.\,\overline{A\,\overline{B}}} = \overline{(\overline{A} + \overline{C})(\overline{C} + D)(\overline{A} + B)}$$

$$= \overline{\overline{\overline{\overline{(\overline{A} + \overline{C})} + \overline{(\overline{C} + D)} + \overline{(\overline{A} + B)}}}}$$



The XOR gate :-

The X-OR gates are formed by a combination of other gates .

The standard logic symbols is shown below :-

The logic expression is :-

$$x = A \oplus B$$

or

$$x = \bar{A}B + A\bar{B}$$

The truth table is :-

I/P		O/P
A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

The X-NOR gate :-

The X-NOR gates are formed by a combination of other gates .

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The logic expression is :-

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or

$$x = \bar{A}\bar{B} + AB$$

The truth table is :-

I/P		O/P
A	B	X
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1	0	0
1	1	1

Applications of X-OR gate

The X-OR functions are very useful in systems require by error detection and correction codes . A parity bit is used for purpose of detecting errors during transmission of binary information . A parity bit is an extra bit included with a binary message to make a number of 1's either odd or even .
The circuit that generates the parity bit in the transmitter is called a parity generator which can be implemented using X-OR gate .

Example / Design a 3- bit even parity generator circuit .

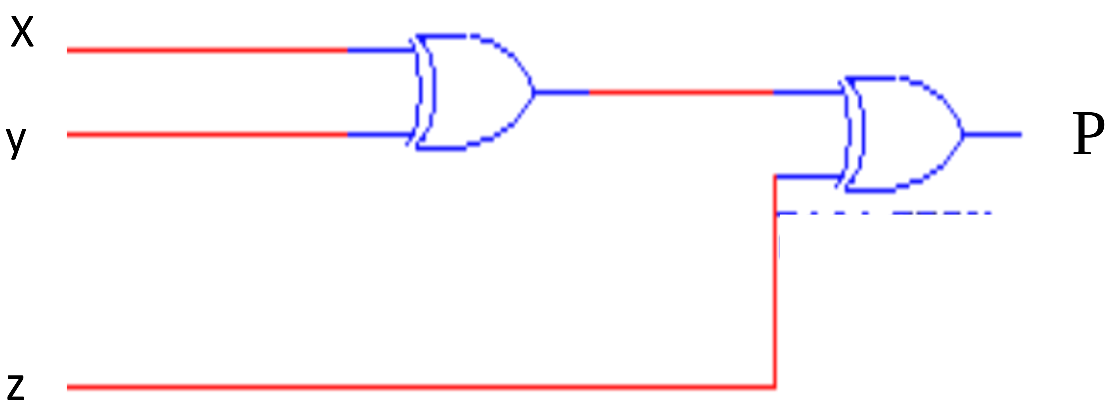
$$P = \bar{x}\,\bar{y}\,z + \bar{x}\,y\,\bar{z} + x\,\bar{y}\,\bar{z} + x\,y\,z$$

$$= \bar{x}\,(\underbrace{\bar{y}\,z + y\,\bar{z}}_{M}) + x\,(\underbrace{\bar{y}\,\bar{z} + y\,z}_{\bar{M}})$$

$$M = y \oplus z$$

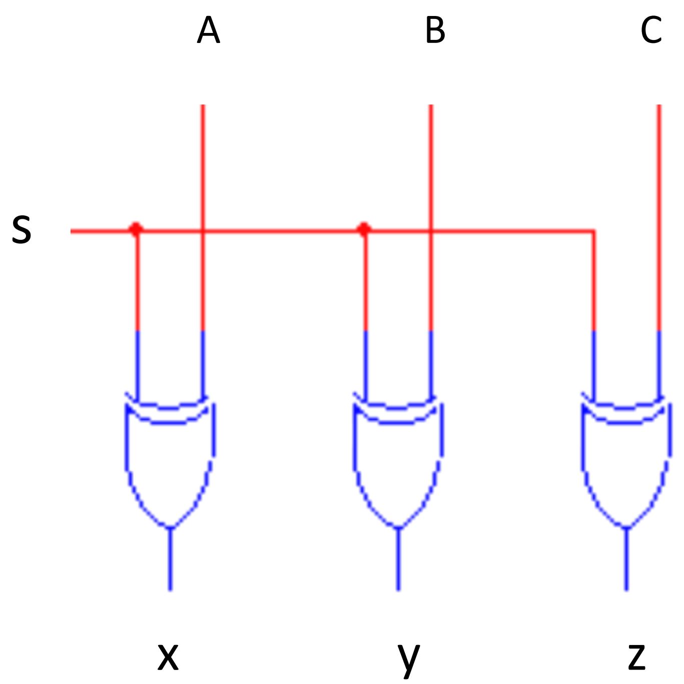
$$P = \bar{x}\,M + x\,\bar{M} = x \oplus M = x \oplus y \oplus z$$

x	y	z	p
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1



Controlled inverter :-

The controlled inverter is used in the computer for subtraction :



The control signal (s)

* IF s = 0 ⟹ x = A , y = B , z = C

* IF s = 1 ⟹ $x = \overline{A}$, $y = \overline{B}$, $z = \overline{C}$

Binary to Gray conversion :-

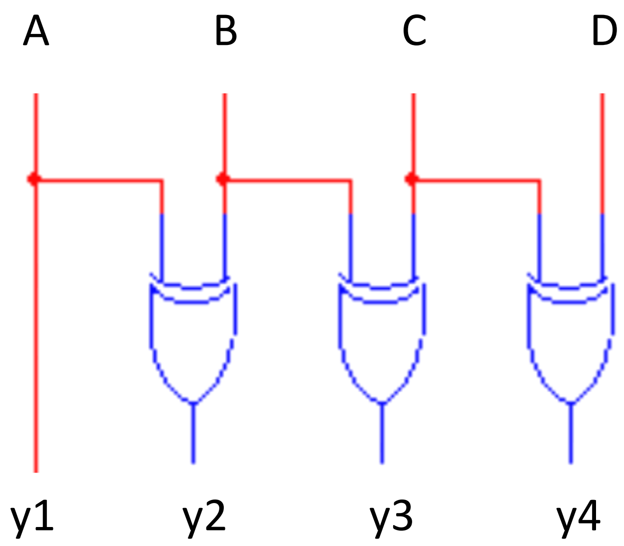
Gray code is unweighted code , not suited to arithmatic but useful for I/P , O/P devices such as shaft encoder, Analogue to digital convertor .

One of the main problem in binary number system is when going from one number to the next , more than one digit position may change at the same time.

But in Gray code every number differs from the preceding number by a single bit .

How to convert from Binary to Gray :-

1.Gray digit is the same as the first Binary digit .
2. Add the list Binary to second Binary digit discard carries .



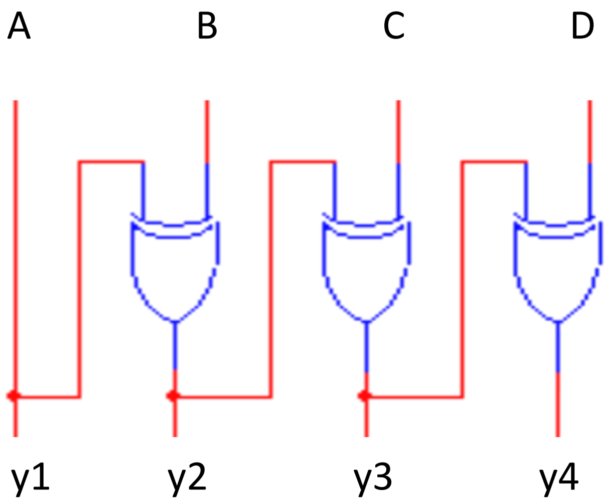
Binary to Gray circuit

Example / convert $(1001)_2$ ⟶ Gray

sol/

A	+	B	+	C	+	D
1	⟶	0	⟶	0	⟶	1
↓						
1		1		0		1
y1		y2		y3		y4

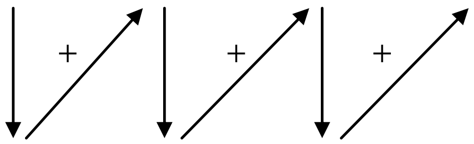
Gray to Binary conversion :-



Example / convert (1101) Gray ⟶ Binary

sol/

	A	B	C	D
	1	1	0	1



1	0	0	1
y1	y2	y3	y4