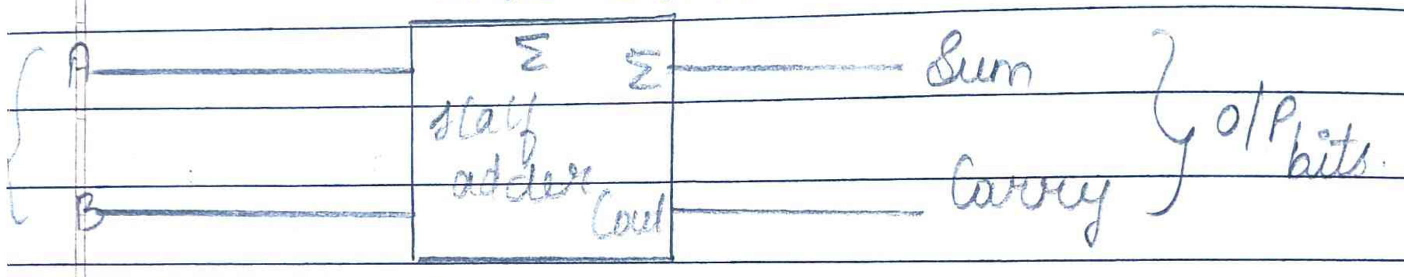
LOGIC CIRCUITS

Explain the working of half adder with logic diagram & truth table

* Half adder is a combinational logic circuit that performs addition of 2 bits.
* It accepts 2 inputs (augend & ~~augund~~ addend) & produces 2 outputs a Sum & a carry bit

LOGIC SYMBOL



Truth Table.

Inputs		Outputs	
A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

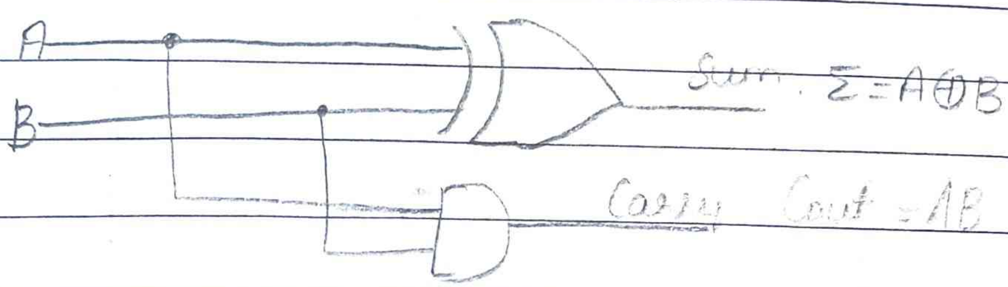
* Carry bit is 1 only when both A&B are 1

$\therefore$ Cout = A.B.

* Sum bit is 1 when both inputs are unequal

$\therefore$ Sum (Σ) = $A \oplus B$.

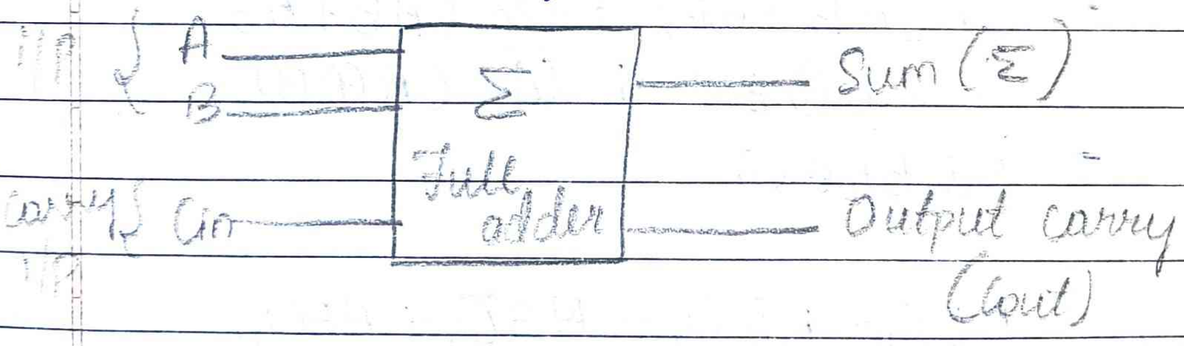
Logic diagram.



2. Explain the working of fulladder with logic diagram & truth table.

A full adder is C.L.C that accepts 2 binary I/P's & an carry input. It generates a sum O/P & an carry O/P.

Logic Symbol.



Truth table

Inputs			Outputs	
A	B	Cin	Sum(Σ)	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

* From half adder the ~~input~~ output of sum ~~is~~ A, B is XORed. Now the ~~input~~ input carry bit Cin is to be added. So Cin is X-ORed with $A \oplus B$.

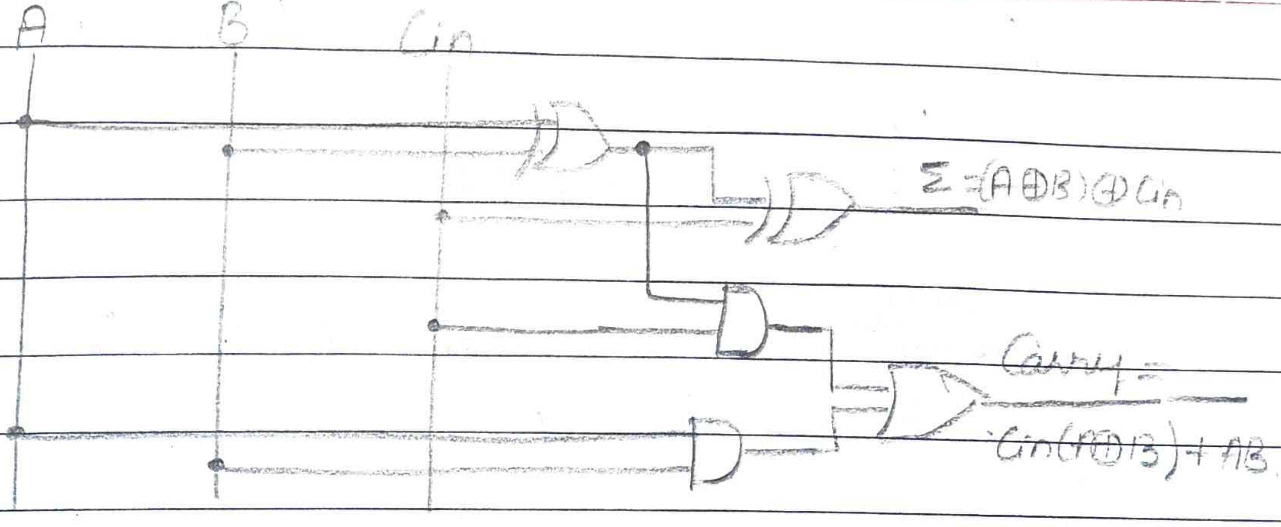
$\therefore$ Sum $= (A \oplus B) \oplus Cin$

Boolean expressions are:-

$$Sum = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$
$$= C_{in}(\bar{A}\bar{B} + AB) + \bar{C}_{in}(\bar{A}B + A\bar{B})$$
$$= C_{in}(\overline{A \oplus B}) + \bar{C}_{in}(A \oplus B)$$
$$= (A \oplus B) \oplus C_{in}$$

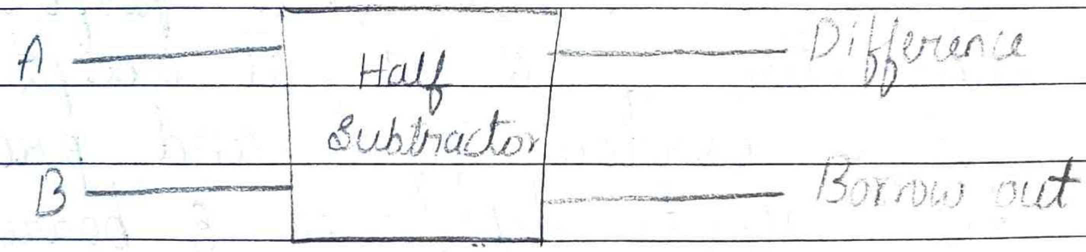
$$Carry = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in}$$
$$= C_{in}(\bar{A}B + A\bar{B}) + AB(\bar{C}_{in} + C_{in})$$
$$= C_{in}(A \oplus B) + AB(1)$$
$$= C_{in}(A \oplus B) + AB$$

Logic diao circuit.



3. Explain the working of half subtractor with logic diagram & truth table.

It is a C.L.C that ~~subtro~~ performs subtraction of 2 binary bits. It accepts 2 i/p's (Minuend & subtrahend) & gives 2 o/p's a difference & a borrow bit.



Truth Table

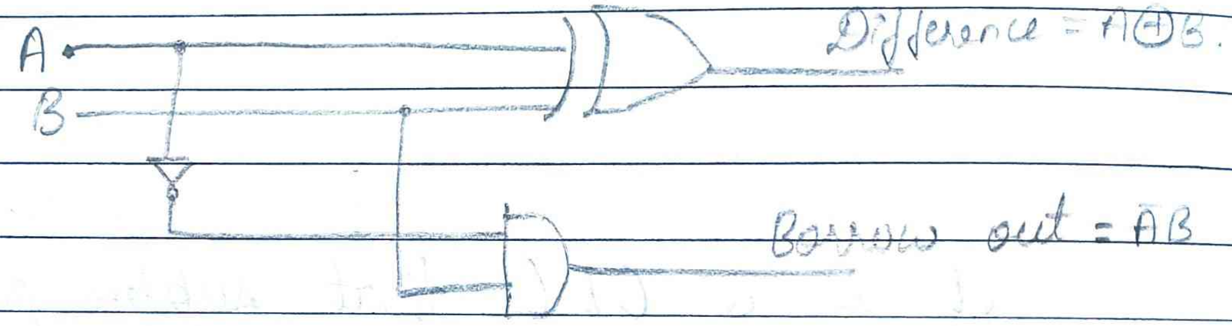
Inputs		Outputs	
A	B	Diff	Bout
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

* Difference is 1 when both I/Ps are unequal.

∴ Difference = $A \oplus B$.

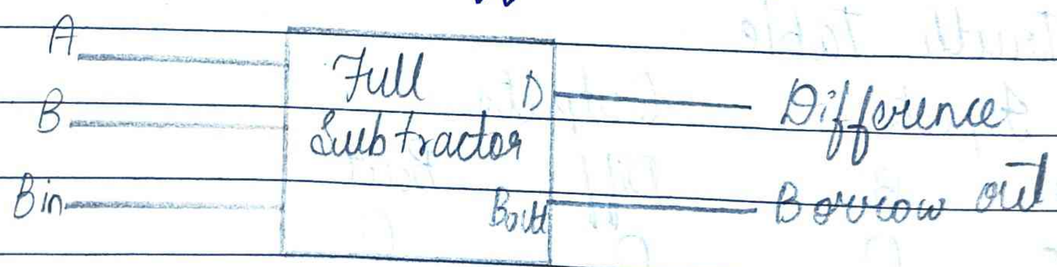
* ~~Sum~~ Borrow out is high when A is 0 & B is 1

∴ Borrow out = $\bar{A}B$.



4. Explain the working of a full subtractor with logic diagram & truth table.

It is a C.L.C that performs the subtraction of 3 bits. It accepts 2 I/p's and a borrow input and produces the outputs difference & borrow output.



Truth Table.

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Inputs			Outputs	
A	B	Bin	D	Bout
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

*. From half subtractor the output of Difference A, B is X-ored. Now the input Bin is to be added. So Bin is X-ORed with $A \oplus B$

$\therefore$ Difference $= (A \oplus B) \oplus Bin$.

Difference $= \bar{A}\bar{B}\,Bin + \bar{A}B\overline{Bin} + \bar{A}\bar{B}\overline{Bin} + AB\,Bin$

$= Bin(\bar{A}\bar{B} + AB) + \overline{Bin}\,(\bar{A}B + A\bar{B})$

$= Bin\,(\overline{A \oplus B}) + \overline{Bin}\,(A \oplus B)$

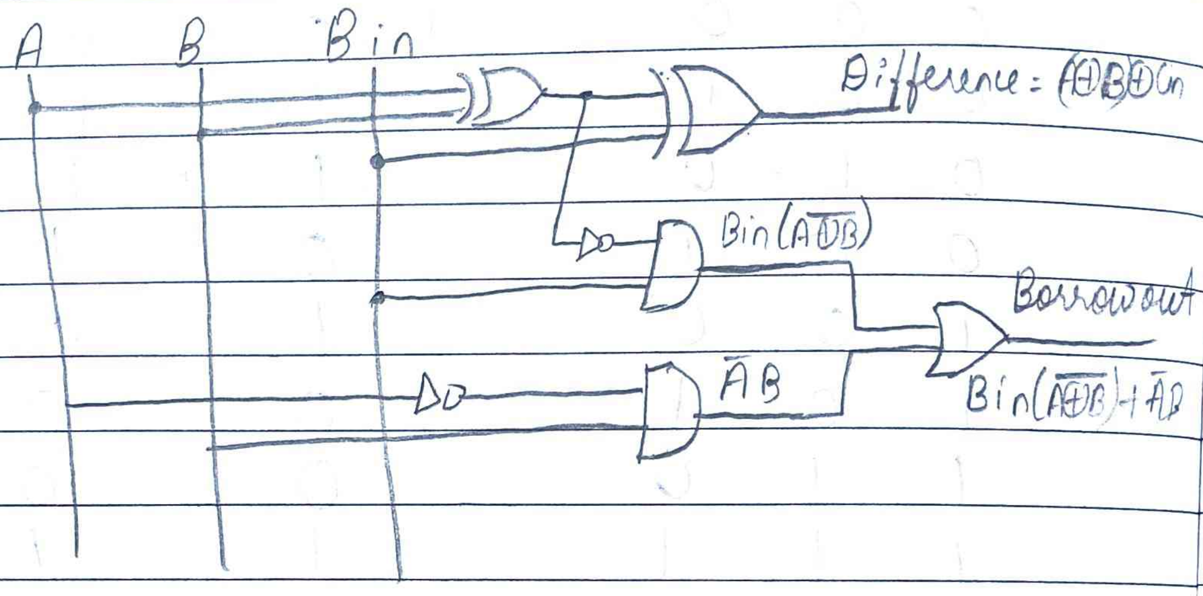
$= (A \oplus B) \oplus Cin.$

Borrow out $= \bar{A}\bar{B}\,Bin + \bar{A}B\overline{Bin} + \bar{A}B\,Bin + AB\,Bin$

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

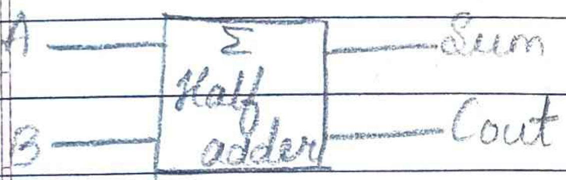
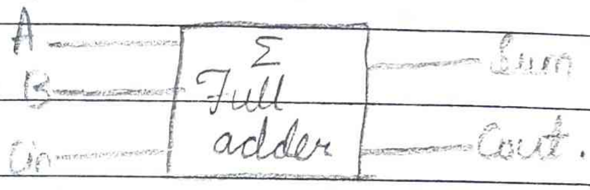
$= Bin\,(\overline{A \oplus B}) + \bar{A}B\,(1)$

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



5. Write difference b/w half adder & full adder.

Half adder	Full adder.
* It adds 2 binary digits & generates sum & carry	It adds 3 binary digits & generates sum & carry
* Carry obtained from previous addition can not be added.	Adds previous carry along with current inputs
* It consists of only one X-OR gate & 1 AND-gate.	It consists of 2 X-OR gates, 2 AND gate & 1 OR gate
* Used in calculators,	* Used in multiple

computers etc	bit addition, digital processors etc
	

6. Define Encoder & Decoder.

Encoder.

It is a C.L.C that accepts a decimal or octal digit on its i/p's & converts it to a coded output such as BCD or Binary. It has 2^n i/p's & n o/p's

Eg:- Decimal to BCD encoder.

Decoder.

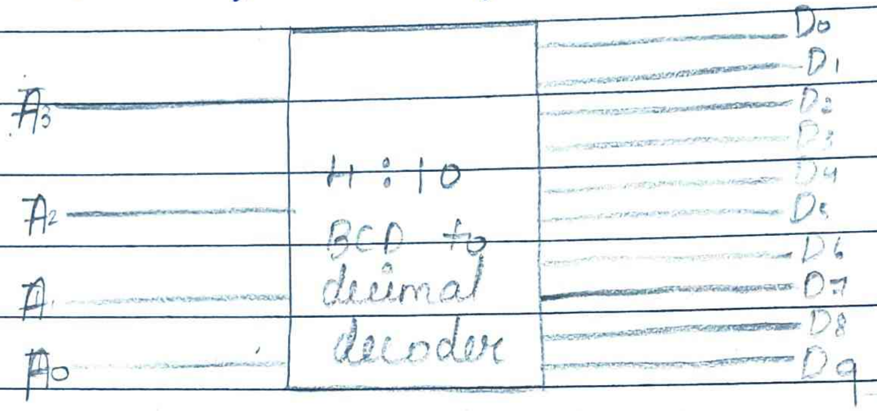
It is a C.L.C that converts coded info into a recognizable format. It has n inputs & 2^n o/p's.

Eg:- BCD to decimal decoder.

7. Explain with a neat ~~diagram~~ circuit & truth table & working of BCD to decimal decoder.

BCD to decimal decoder is also called

as 4-line-to 10-line decoder. The logic symbol of ~~BCD~~ is.



Truth Table.

BCD I/P's				Output (Decoding function)										Deci digit
A_3	A_2	A_1	A_0	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	1	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	1	0	0	0	0	0	0	0	2
0	0	1	1	0	0	0	1	0	0	0	0	0	0	3
0	1	0	0	0	0	0	0	1	0	0	0	0	0	4
0	1	0	1	0	0	0	0	0	1	0	0	0	0	5
0	1	1	0	0	0	0	0	0	0	1	0	0	0	6
0	1	1	1	0	0	0	0	0	0	0	1	0	0	7
1	0	0	0	0	0	0	0	0	0	0	0	1	0	8
1	0	0	1	0	0	0	0	0	0	0	0	0	1	9

Boolean equations

$D_0 = \bar{A}_3 \bar{A}_2 \bar{A}_1 \bar{A}_0$

$D_1 = \bar{A}_3 \bar{A}_2 \bar{A}_1 A_0$

$D_2 = \bar{A}_3 \bar{A}_2 A_1 \bar{A}_0$

$D_3 = \bar{A}_3 \bar{A}_2 A_1 A_0$

$D_4 = \bar{A}_3 A_2 \bar{A}_1 \bar{A}_0$

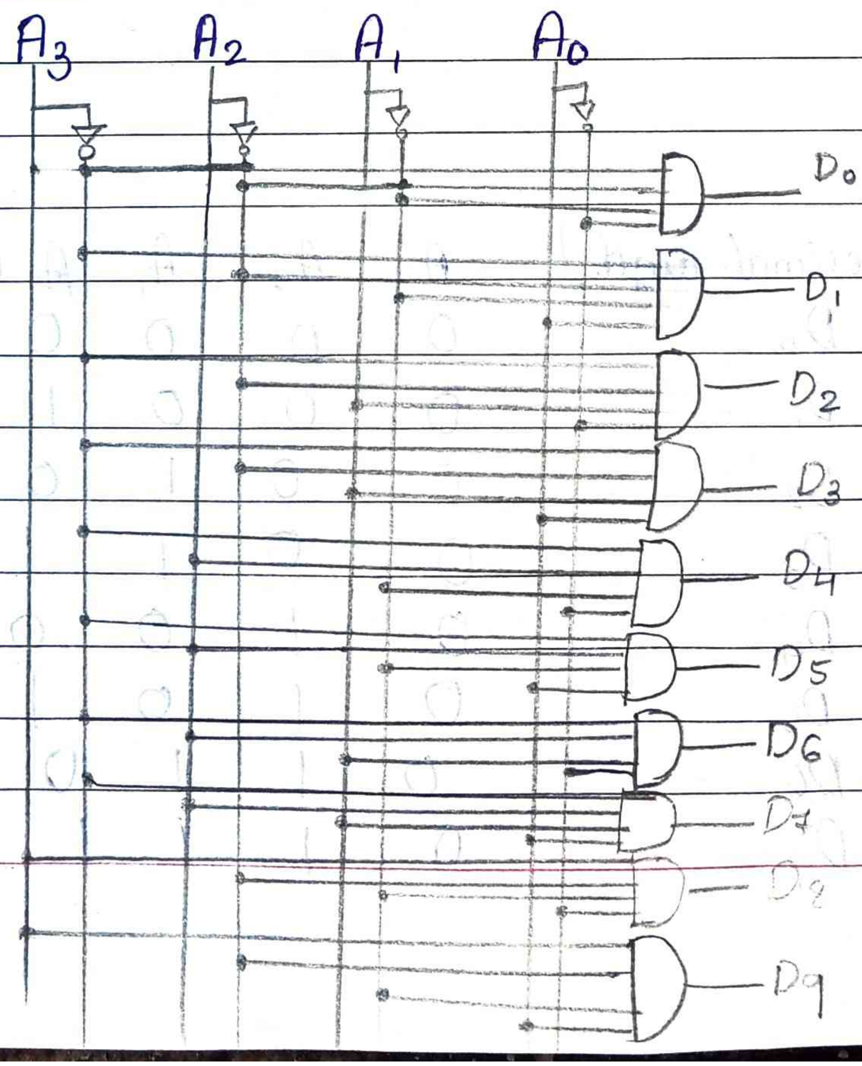
$D_5 = \bar{A}_3 A_2 \bar{A}_1 A_0$

$D_6 = \bar{A}_3 A_2 A_1 \bar{A}_0$

$D_7 = \bar{A}_3 A_2 A_1 A_0$

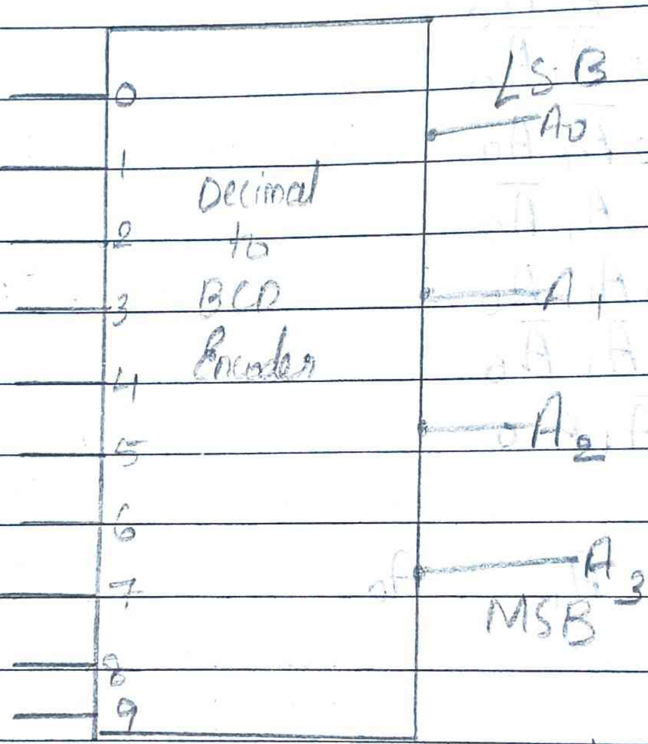
$D_8 = A_3 \bar{A}_2 \bar{A}_1 \bar{A}_0$

$D_9 = A_3 \bar{A}_2 \bar{A}_1 A_0$



8. Explain with a neat circuit & truth table the working of Decimal to BCD encoder

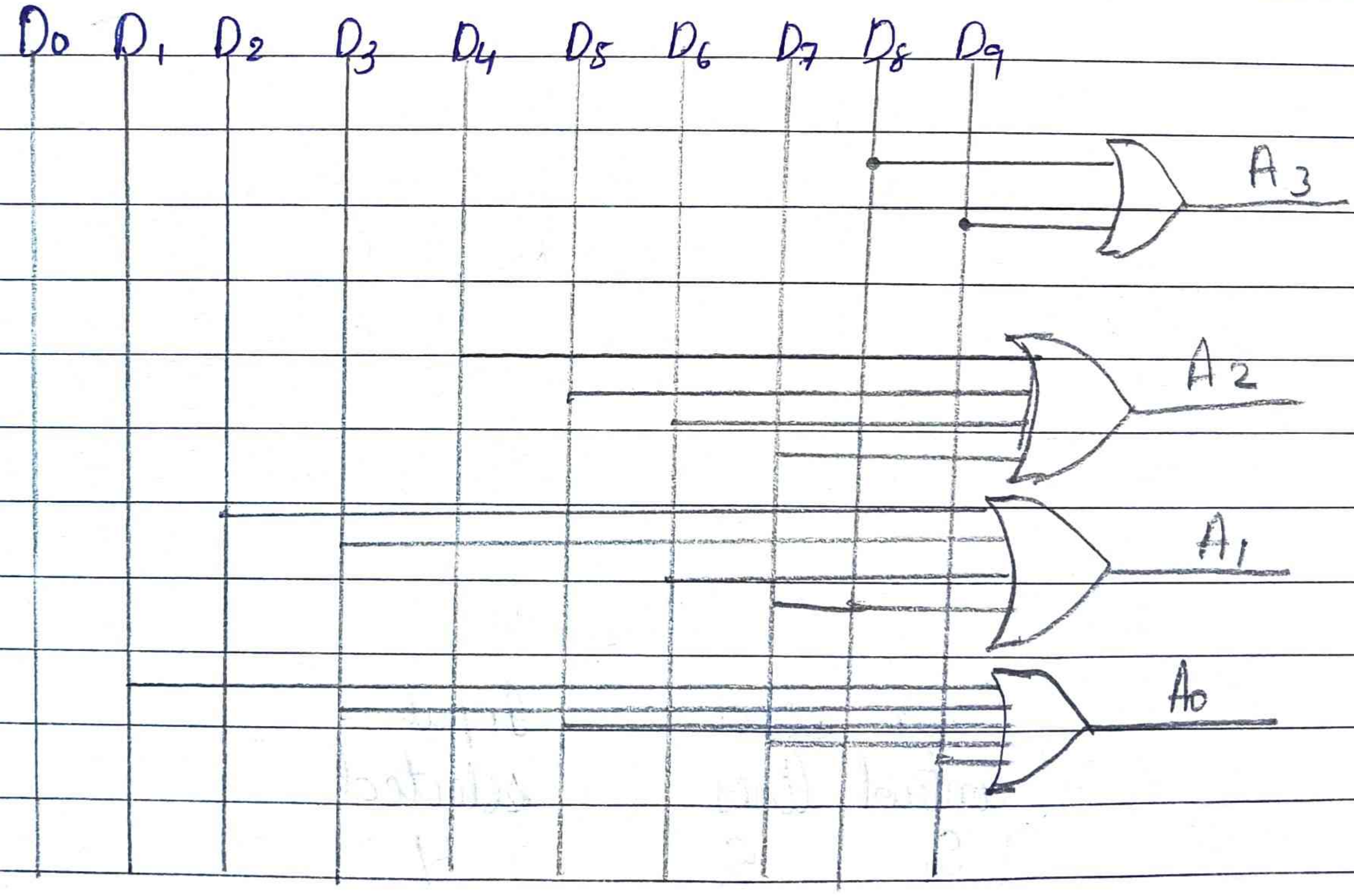
It is called as 10-4 line encoder.



Input (Decimal digit)		A_3	A_2	A_1	A_0 (BCD code)
0	D_0	0	0	0	0
1	D_1	0	0	0	1
2	D_2	0	0	1	0
3	D_3	0	0	1	1
4	D_4	0	1	0	0
5	D_5	0	1	0	1
6	D_6	0	1	1	0
7	D_7	0	1	1	1

8	D_8	1	0	0	0
9	D_9	1	0	0	1

$A_3 = D_8 + D_9$
$A_2 = D_4 + D_5 + D_6 + D_7$
$A_1 = D_2 + D_3 + D_6 + D_7$
$A_0 = D_1 + D_3 + D_5 + D_7 + D_9$

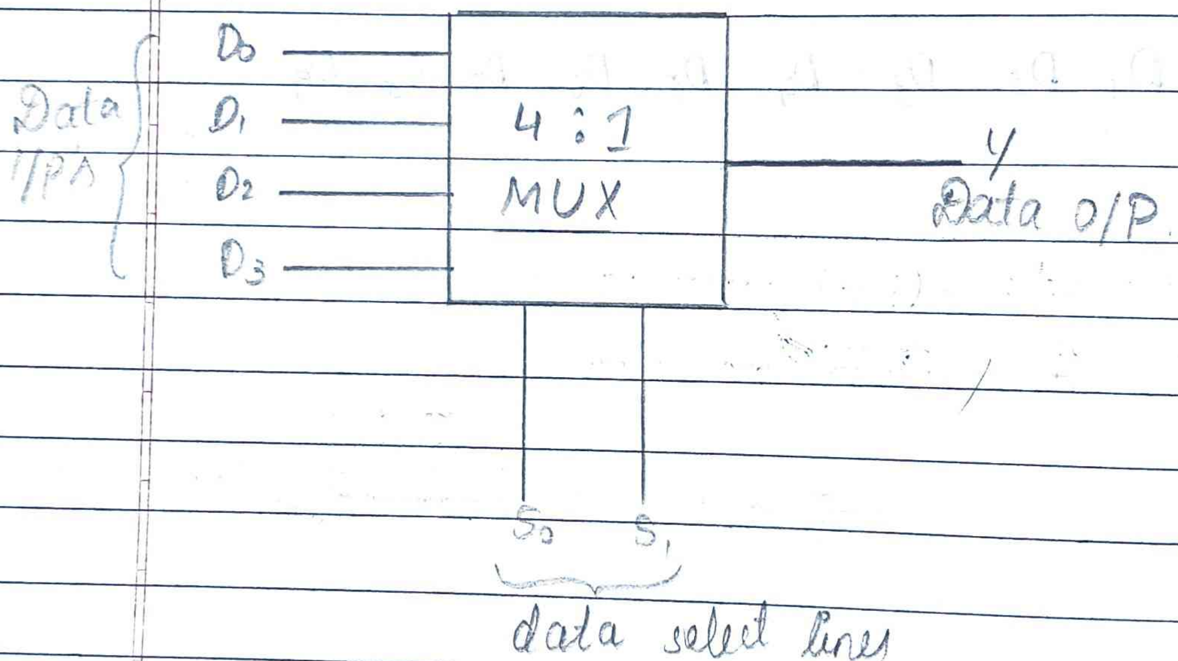


9. Explain with a neat circuit and truth table, the working of 4:1 Mux

* Multiplexers also known as Data Selector
* It consists of many i/p's & single o/p.

A 4:1 MUX have 4 data i/p's & 1 o/p line with 2 data-select control lines.

Logic Symbol.



Data select Control lines		Input selected
S_1	S_0	Y
0	0	D_0
0	1	D_1
1	0	D_2
1	1	D_3

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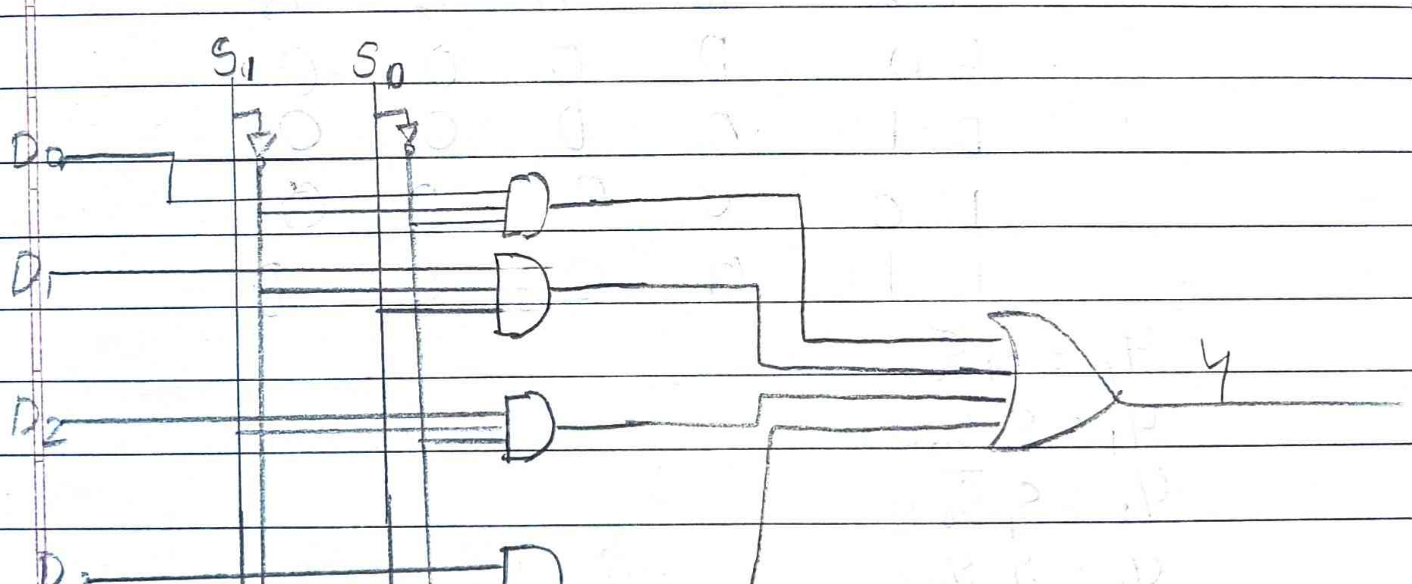
Boolean expression,

$$Y = D_0\bar{S}_1\bar{S}_0 + D_1\bar{S}_1 S_0 + D_2 S_1\bar{S}_0 + D_3 S_1 S_0.$$

i.e

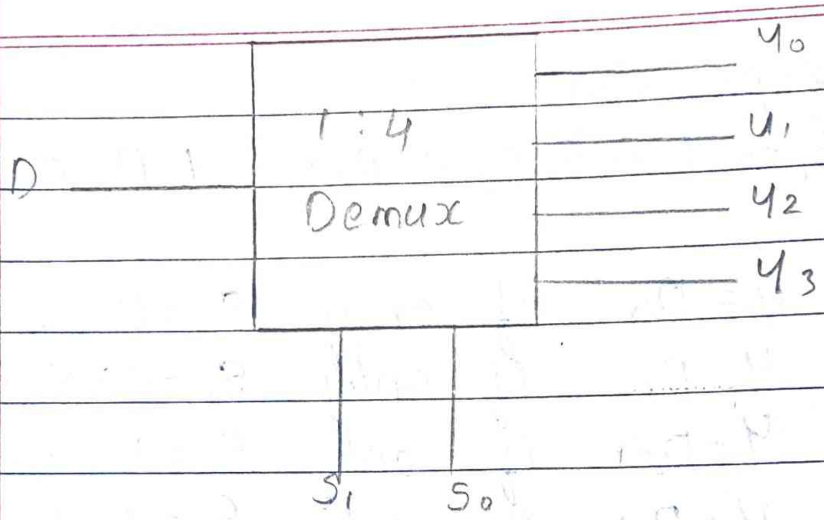
output $Y = D_0$ if only $S_1 = 0$ $S_0 = 0$
output $Y = D_1$ if only $S_1 = 0$ $S_0 = 1$
output $Y = D_2$ if only $S_1 = 1$ $S_0 = 0$
Output $Y = D_3$ if only $S_1 = 1$ $S_0 = 1$

Logic diagram.



10. Explain with a neat circuit & truth table, working of demux

They are also known as Data Distributor. It consists of ~~m~~ 1 i/p & many o/p's. A 1:4 demux have 1 i/p 2 select line & 4 outputs.



Truth Table

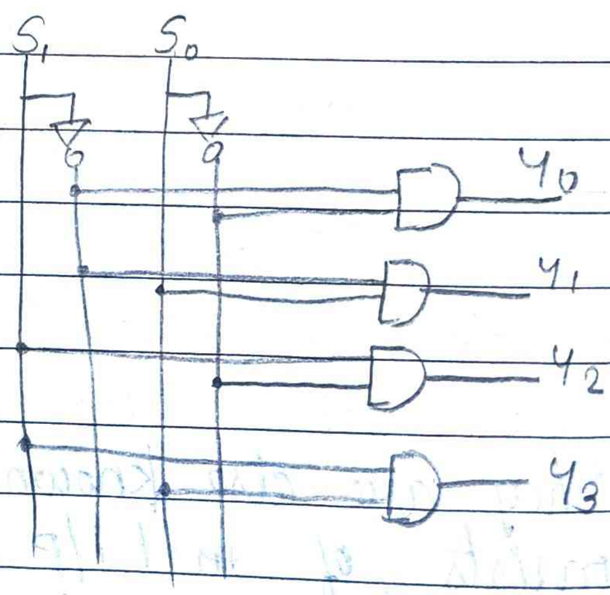
I/P's		O/P			
S_1	S_0	Y_0	Y_1	Y_2	Y_3
0	0	D	0	0	0
D	1	0	D	0	0
1	0	0	0	D	0
1	1	0	0	0	D

$Y_0 = \bar{S}_1 \bar{S}_0 D$

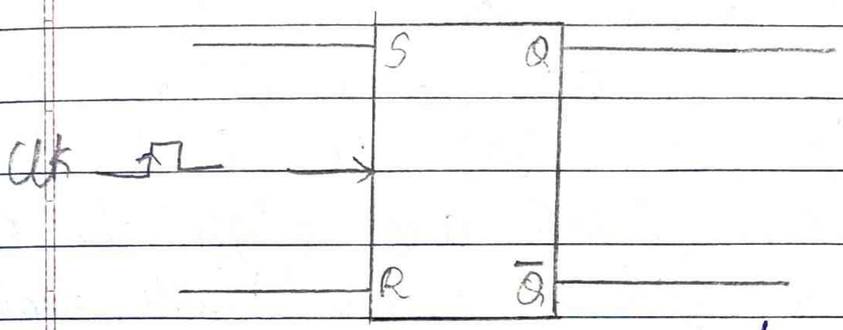
$Y_1 = \bar{S}_1 S_0 D$

$Y_2 = S_1 \bar{S}_0 D$

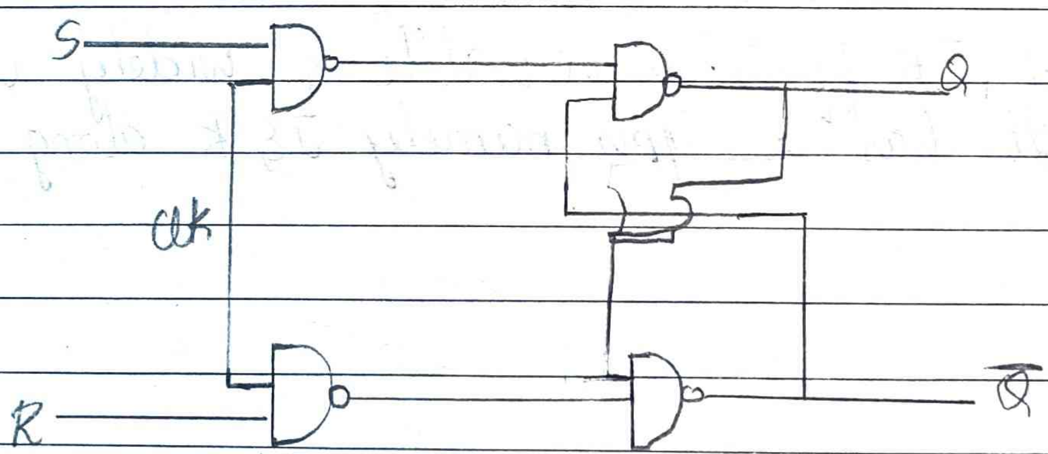
$Y_3 = S_1 S_0 D$



11. Explain SR Flip-Flop with logic circuit diagram & truth Table.



Logic symbol +ve edge triggered flip-flop.



Inputs			Outputs		Comments
S	R	Clk	Q	$\overline{Q}$	
0	0	1	Q	$\overline{Q}$	No change
0	1	1	0	1	Reset
1	0	1	1	0	Set
1	1	1	?	?	Invalid.