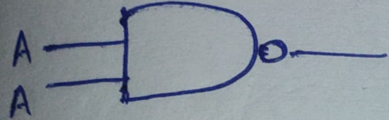
1. 

$\overline{A \cdot A} = \bar{A}$

$A = 0$, Output $= 1$

$A = 1$, output $= 0$

(NOT)

de Morgan,

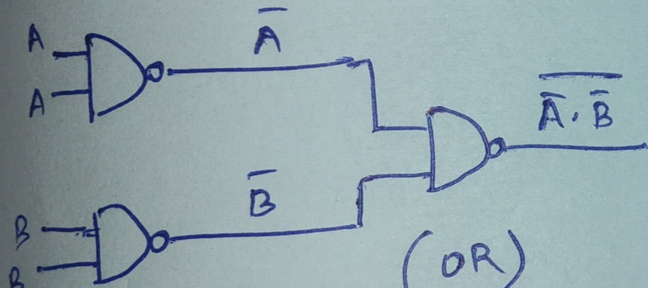
$\overline{A \cdot B} = \bar{A} + \bar{B}$

$\overline{A + B} = \bar{A} \cdot \bar{B}$

Then,

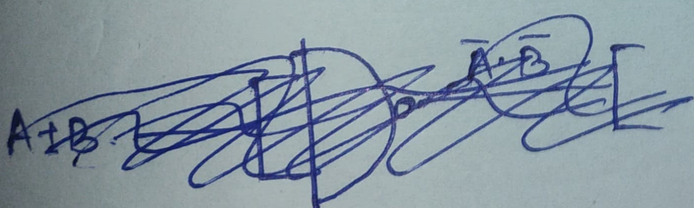
$\overline{\bar{A} \cdot \bar{B}} = A + B$

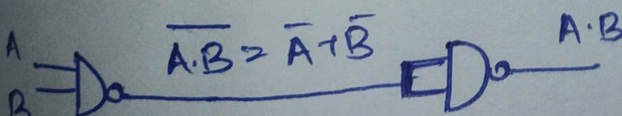
$\overline{\bar{A} + \bar{B}} = AB$



$\overline{\bar{A} \cdot \bar{B}} = A + B$

(OR)



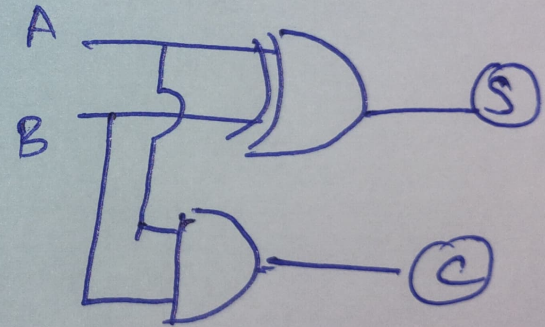


2. <u>Half Adder</u>

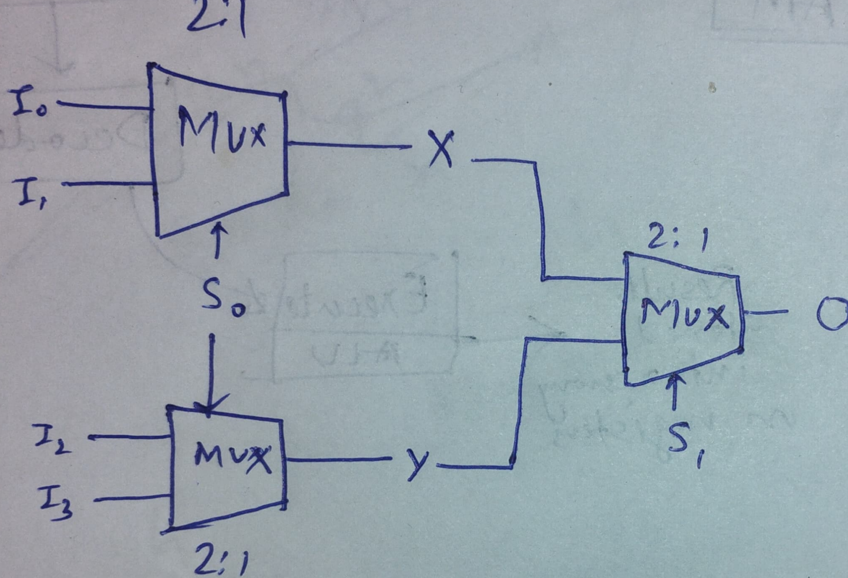
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$S = A \oplus B$

$C = A \cdot B$



3.



To choose I_0,
$S_0 = 0$, $S_1 = 0$
To choose I_1,
$S_0 = 1$, $S_1 = 0$
To choose I_2
$S_0 = 0$, $S_1 = 1$
To choose I_3
$S_0 = 1$, $S_1 = 1$

$$\boxed{\begin{aligned} X &= \bar{S}_0 I_0 + S_0 I_1 \qquad O = \bar{S}_1 X + S_1 y \\ y &= \bar{S}_0 I_2 + S_0 I_3 \end{aligned}}$$

4. Two flip-flops are required

be the output of the FFs are S_1 and S_2

S_1	S_2	
0	0	$\rightarrow$ 0 1's
0	1	$\rightarrow$ 1 1's (together)
1	0	$\rightarrow$ 2 1's (together)

$P = 1 \rightarrow$ when 3 trailing 1's are observed.

Two cycles $\underline{S_1 S_2}$ and $\underline{S_{1\,next}\ S_{2\,next}}$ are taken,

iff. $(S_1, S_2) \equiv (1, 0)$ and $(S_{1\,next}, S_{2\,next}) \equiv (1, 0)$

then, $P = 1$

i.e.

S_1	S_2	$S_{1\,next}$	$S_{2\,next}$	P
0	0	0	0	0
0	0	0	1	0
0	1	0	0	0
0	1	0	1	0
1	0	0	0	0
1	0	1	1	$\boxed{1}$

5.

Q_1	Q_0	Q_1^*	Q_0^*
0	0	0	1
0	1	1	0
1	0	1	1
1	1	0	0

$$Q_1^* = Q_1 \oplus Q_0$$

$$Q_0^* = \overline{Q_0}$$