COMPUTER SCIENCE & IT

DIGITAL LOGIC

Lecture No. 01

Combinational Circuit

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Question Practice

Comb. CKt.

Q. $\bar{A}B \oplus \bar{B}C \oplus A\bar{B}C$ is equal to

a. $\bar{A}B + \bar{A}C$

b. $\bar{A}B + \bar{B}C$ X

c. $A\bar{B} + \bar{B}C$ X

d. $A\bar{B} + \bar{A}C$

$$\underbrace{\bar{A}B}_{P} \oplus \underbrace{\bar{B}C}_{Q} \oplus \underbrace{A\bar{B}C}_{P\cdot Q}$$

$$\bar{A}B \cdot \bar{B}C = 0$$

$$\bar{A}B \oplus \left[\bar{B}C \oplus A\bar{B}C\right]$$

$$\bar{A}B \oplus \left[\bar{B}C(1 \oplus A)\right] = \bar{A}B \oplus \left[\bar{A}\bar{B}C\right] = \bar{A}B + \bar{A}\bar{B}C = \bar{A}\left[B + \bar{B}C\right]$$

$$= \bar{A}\left[(B+\bar{B})(B+C)\right]$$

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

$\bar{A}B \oplus \bar{B}C \oplus A\bar{B}C$

$\Sigma(2,3) \quad \Sigma 1,5 \quad \Sigma 5 \qquad = \Sigma(1,2,3)$

$\bar{A}B$

$0\;1\;0 \rightarrow 2$

$0\;1\;1 \rightarrow 3$

$\bar{B}C$

$0\;0\;1 \rightarrow 1$

$1\;0\;1 \rightarrow 5$

$A\bar{B}C$

$1\;0\;1$

$$= \bar{A}\bar{B}C + \bar{A}B\bar{C} + \bar{A}BC$$

$\bar{A}B$

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

$$= \bar{A}[B + \bar{B}C]$$

$$= \bar{A}[B + C]$$

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

- $f(A,B,C) = \Sigma(3,5,6,7) = \Pi(0,1,2,4)$ self dual

$\overline{f} = \Sigma(0,1,2,4) = \Pi(3,5,6,7) \longrightarrow$ self dual

Note:→ if f is self dual boolean function then $\overline{f}$ will be definitely a self dual boolean function.

Type of Digital Circuit

- Combinational Circuit
- Sequential Circuit

Comb. CKt.

1. O/P depends on present i/p only.
2. There is no feedback.
3. There is no memory.

• eg. H.A., F.A, H.S, F.S, MUX, decoder, Encoder etc.

Seq. CKt.

1. O/P depends on present i/p and past i/p.
2. There is feedback.
3. There is memory.

eg F.F., Counters, Shift registers, Johnson Counter etc.

How to Design Combinational Circuit

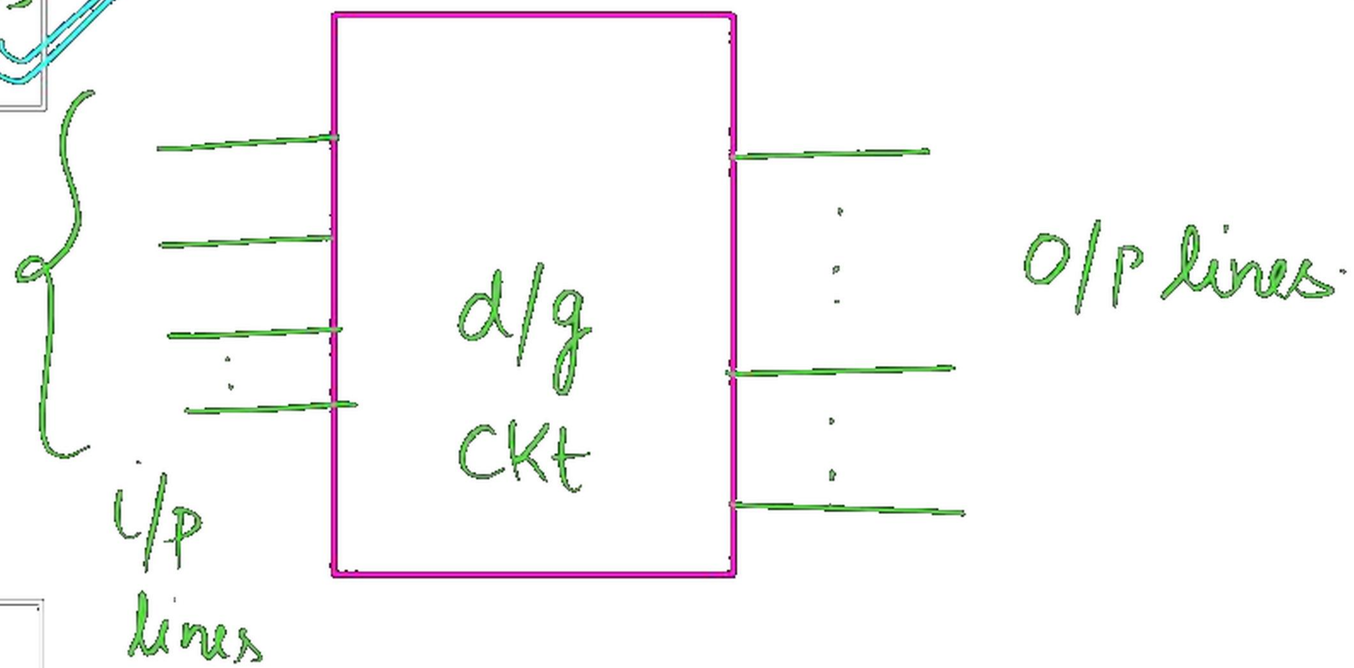
1. Identify the no. of i/p lines & no. of o/p lines

2. Write down the truth table b/w i/p lines and o/p lines.

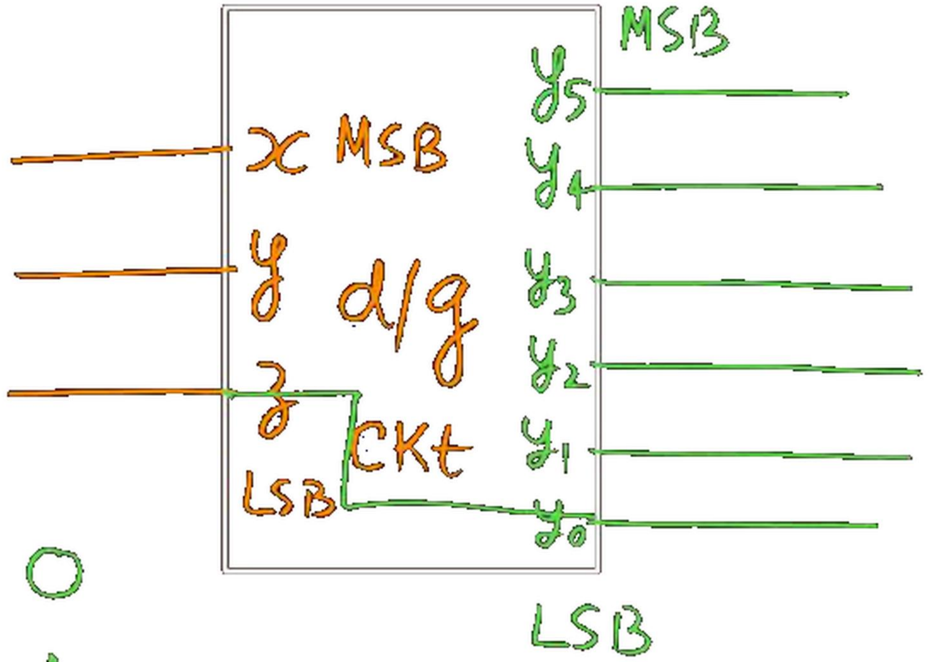
3. Write down o/ps in terms of SOP or POS

4. Then simplify every o/p using Boolean theorem or K-Map.

5. Now implement the o/ps using gates.



x	y	z	y_5	y_4	y_3	y_2	y_1	y_0
0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	1
0	1	0	0	0	0	1	0	0
0	1	1	0	0	1	0	0	1
1	0	0	0	1	0	0	0	0
1	0	1	0	1	1	0	0	1
1	1	0	1	0	0	1	0	0
1	1	1	1	1	0	0	0	1



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0
1
4
9
16
49

$y_5(x,y,z) = \Sigma(6,7)$

$y_4(x,y,z) = \Sigma(4,5,7)$

$y_3(x,y,z) = \Sigma(3,5)$

$y_2(x,y,z) = \Sigma(2,6)$

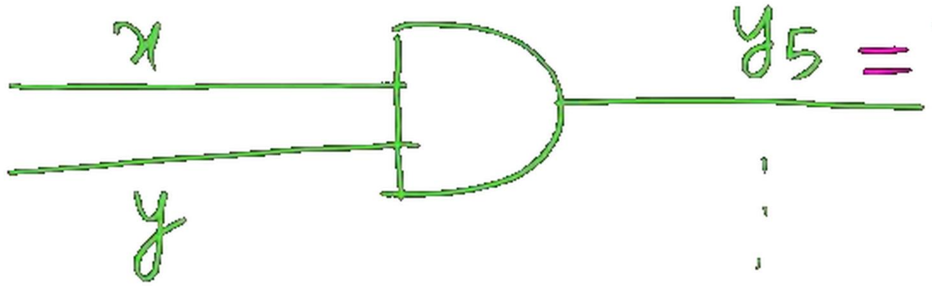
$y_1(x,y,z) = \Sigma(\text{nil}) = 0$

$y_0(x,y,z) = \Sigma(1,3,5,7) = z$

$$y_5 = \Sigma(6,7)$$

$$= \underline{xy\bar{z}} + xyz$$

$$= xy$$



$y_5 = x \cdot y$

y_4

y_0

Standard Combinational Circuits

- Half Adder
- Half Subtractor
- Full Adder
- Full Subtractor

$$
\begin{array}{r}
(786)_{10} \\
+\ (259)_{10}
\end{array}
$$

$$
\begin{array}{cccc}
 & 7 & 8 & 6 \\
 & 2 & 5 & 9 \\
 & 1 & 1 & \\
\hline
1 & 0 & 4 & 5 \\
\hline
\end{array}
$$

$$
\begin{array}{rccc}
 & & 3 & 6 \\
+ & & 8 & 2 \\
 & & 0 & \\
\hline
 & 1 & 1 & 8
\end{array}
$$

$$
\Rightarrow \quad
\begin{array}{rl}
 & \overset{8^1 8^0}{(26)_8} = (16+6)_{10} = (22)_{10} \\
+ & (35)_8 = (24+5)_{10} = (29)_{10} \\
 & 1 \\
\hline
 & (0\ 6\ 3)_8 = (48+3)_{10} \\
 & = (51)_{10}
\end{array}
$$

$$
\begin{array}{rl}
 & \overset{6^1 6^0}{(24)_6} = (12+4)_{10} \\
+ & (5\ 3)_6 = (30+3)_{10} \\
 & 6^2 \quad 1 \\
\hline
 & (1\ 2\ 1)_6 = (36+12+1)_{10}
\end{array}
$$

$$(\overset{8^1}{3}\overset{8^0}{6})_8 = (24+6)_{10}$$

$$(42)_8 = (32+2)_{10}$$

$$\begin{array}{r} {}^{8^2}\ 1 \\ \hline (1\ 0\ 0)_8 \end{array} = (64+0+0)_{10}$$

- $$\begin{array}{r} (3\ 2)_8 \\ (4\ 5)_8 \\ 0 \\ \hline (0\ 7\ 7)_8 \end{array}$$

- $$\begin{array}{r} (101)_2 \\ +\ (101)_2 \\ \hline \end{array}$$

$$\begin{array}{rrrr} & 1 & 0 & 1 \\ & 1 & 0 & 1 \\ & 0 & 1 & \\ \hline 1 & 0 & 1 & 0 \end{array}$$

$$(1\,1\,1)_2$$

$$+\ (1\,1\,1)_2$$

$$\begin{array}{cccc}
 & 1 & 1 & 1 \\
 & 1 & 1 & 1 \\
 & 1 & 1 & \\
\hline
1 & 1 & 1 & 0
\end{array}$$

$$
\begin{array}{lccccc}
A = & & a_3 & a_2 & a_1 & a_0 \\
B = + & & b_3 & b_2 & b_1 & b_0 \\
 & & C_3 & C_2 & C_1 & \\
\hline
\text{Result} \Rightarrow & C_4 & S_3 & S_2 & S_1 & S_0 \\
\hline
\end{array}
$$

2 Minute Summary

→ Comb. CKt.

Thank you

GW

Soldiers !