CMR INSTITUTE OF TECHNOLOGY			
Solutons of Internal Assesment Test - I			
Sub:	**DIGITAL SYSTEM DESIGN**	Code:	18EE35
Sem: 3rd		Branch:	EEE

1. Distinguish prime implicants and essential prime implicants. Determine prime implicants and essential prime implicants of Y=f(a,b,c,d)= πM (0,1,4,5,8,9,11)+d(2,10) and obtain the final expression.

Solution:

→ Prime Implicants	Essential Prime Implicants
① In k-map, after grouping the cells, the sum terms having the minterm that appears are called prime implicant groups. And the minterms are known as prime implicant.	① In k-map, after grouping the cell, it is observed that some cells may appear in only one prime implicant groups. These are known as essential prime implicants.
② All prime Implicants are not essential prime implicants.	② All essential prime implicants are the prime implicants
③ Example:	③ Example: from fig, cells 1, 4, 9, 10 are appeared only in one prime implicants group.

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

AB \ CD				
	1_0	1_1	0_3	0_2
	1_4	0_5	0_7	0_6
	0_{12}	0_{13}	0_{15}	0_{14}
	1_8	1_9	0_{11}	1_{10}

Cell 0, 1, 4, 8, 9, 10 are all from prime implicant group.

Solution : Prime implicants :

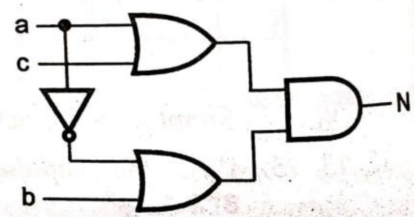
ab \ cd	c+d	c+$\bar{d}$	$\bar{c}$+$\bar{d}$	$\bar{c}$+d
a+b	0	0		x
a+$\bar{b}$	0	0		
$\bar{a}$+$\bar{b}$				
$\bar{a}$+b	0	0	0	x

$$N = (a + c)(\bar{a} + b)\ (b + c)$$

Essential prime implicants :

$$N = (a + c)\ (\bar{a} + b)$$

Implementation :



2. Find a minimum SOP solution using Quine-McCluskey method F(a,b,c,d)=∑m(2,3,4,5,13,15) +d(8,9,10,11).

Solution:

Step 1 : List all minterms in binary form.

Minterms	Binary representation			
m_2	0	0	1	0
m_3	0	0	1	1
m_4	0	1	0	0
m_5	0	1	0	1
m_{13}	1	1	0	1
m_{15}	1	1	1	1
dm_8	1	0	0	0
dm_9	1	0	0	1
dm_{10}	1	0	1	0
dm_{11}	1	0	1	1

Step 2 : Arrange the minterms according to number of 1's.

Minterms	Binary representation			
m_2	0	0	1	0
m_4	0	1	0	0
m_8	1	0	0	0
m_3	0	0	1	1
m_5	0	1	0	1
m_9	1	0	0	1
m_{10}	1	0	1	0
m_{11}	1	0	1	1
m_{13}	1	1	0	1
m_{15}	1	1	1	1

Step 3 :

Minterm			Binary representation			
2,	3	✓	0	0	1	–
2,	10	✓	–	0	1	0
4,	5		0	1	0	–
8,	10	✓	1	0	–	0
8,	9	✓	1	0	0	–
3,	11	✓	–	0	1	1
5,	13		–	1	0	1
9,	13	✓	1	–	0	1
9,	11	✓	1	0	–	1
10,	11	✓	1	0	1	–
13,	15	✓	1	1	–	1
11,	15	✓	1	–	1	1

Step 4 :

Minterm				Binary representation			
2,	3,	10,	11	–	0	1	–
8,	9,	10,	11	1	0	–	–
9,	11,	13,	15	1	–	–	1

Step 5 :

Prime implicants				Binary representation			
$\bar{a}$	b	$\bar{c}$	4, 5	0	1	0	–
b	$\bar{c}$	d	5, 13	–	1	0	1
$\bar{b}$	c		2, 3, 10, 11	–	0	1	–
a	$\bar{b}$		8, 9, 10, 11	1	0	–	–
a	d		9, 11, 13, 15	1	–	–	1

Step 6

Prime Implicants	m_2	m_3	m_4	m_5	m_{13}	m_{15}	dm_8	dm_9	dm_{10}	dm_{11}
4, 5 $\bar{a} b \bar{c}$			⊙	•						
5, 13 $b \bar{c} d$				•	•					
2, 3, 10, 11 $\bar{b} c$	⊙	⊙							•	•
8, 9, 10, 11 $a \bar{b}$							•	•	•	•
9, 11, 13, 15 $a d$					•	⊙		•		•

$$\boxed{\therefore Y = \bar{b} c + \bar{a} b \bar{c} + a d}$$

3. Place the following equations into proper canonical forms:

(a) P=f(a,b,c) = ab'+ab'+bc

(b) T= f(a,b,c)= (a+b')(b'+c)

Solution:

(a) $P = f(a,b,c) = ab' + ab' + bc$

$= ab'(c+c') + ab'(c+c') + bc(a+a')$

$= ab'c + ab'c' + ab'c + ab'c' + abc + a'bc$

$$\boxed{\therefore\ f(a,b,c) = ab'c + ab'c' + abc + a'bc.}$$

Canonical Form.

(b) $T = f(a,b,c) = (a+b')(b'+c)$

$= (a+b'+cc')(aa'+b'+c)$

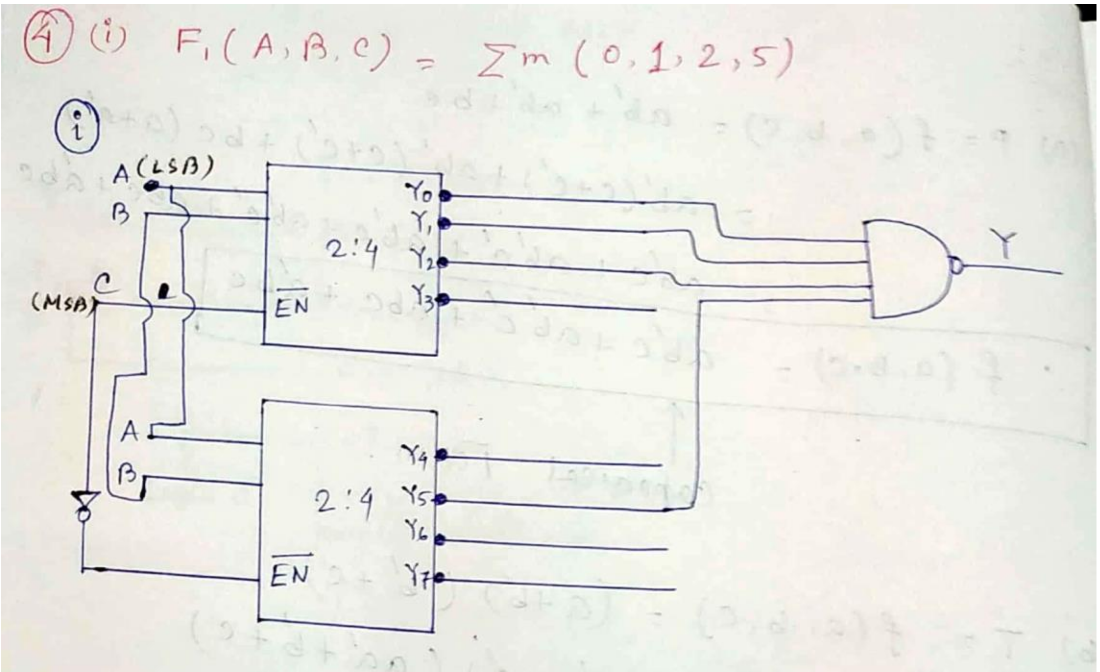
$= (a+b'+c)(a+b'+c')(a+b'+c)(a'+b'+c)$

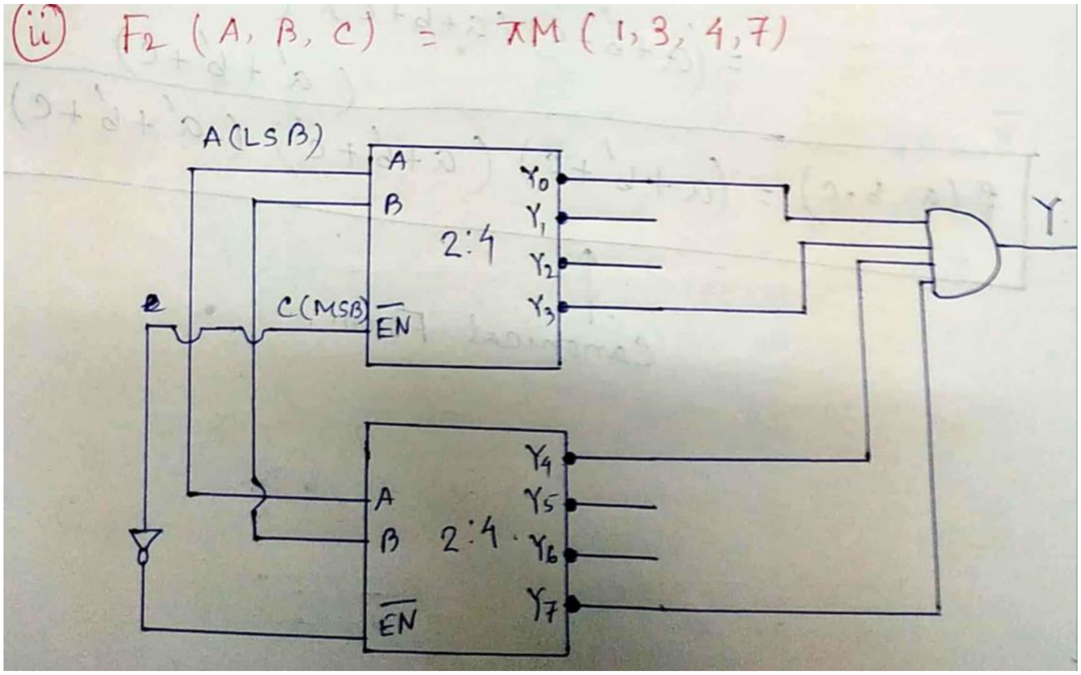
$$\boxed{f(a,b,c) = (a+b'+c)(a+b'+c')(a'+b'+c)}$$

Canonical Form.

4. Implement the function using active low output dual 2:4 decoder line decoder IC 74139
i)$F_1(A,B,C)=\sum m(0,1,2,5)$ ii)$F_2(A,B,C)=\pi M(1,3,4,7)$

Solution:





5. What is the problem associated with the parallel adder? Explain the method of correcting it, with suitable circuit equations.

Solution:

The parallel adder is ripple carry adder in which the carry output of each full-adder stage is connected to the carry input of the next higher-order stage. Therefore, the sum and carry outputs of any stage cannot be produced until the input carry occurs; this leads to a time delay in the addition process. This delay is known as **carry propagation delay.**

One method of speeding up this process by eliminating inter stage carry delay is called **look ahead-carry addition.** This method utilizes logic gates to look at the lower-order bits of the augend and addend to see if a higher-order carry is to be generated. It uses two functions : carry generate and carry propagate.

Consider the circuit of the full-adder shown in Fig. 2.11.1. Here, we define two functions : carry generate and carry propagate.

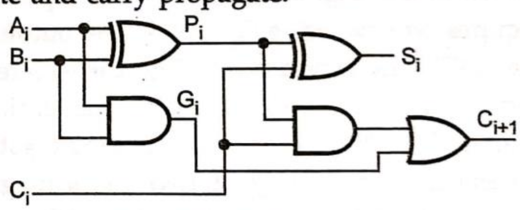


Fig. 2.11.1 Full-adder circuit

$$P_i = A_i \oplus B_i$$

$$G_i = A_i B_i$$

The output sum and carry can be expressed as

$$S_i = P_i \oplus C_i$$

$$C_{i+1} = G_i + P_i C_i$$

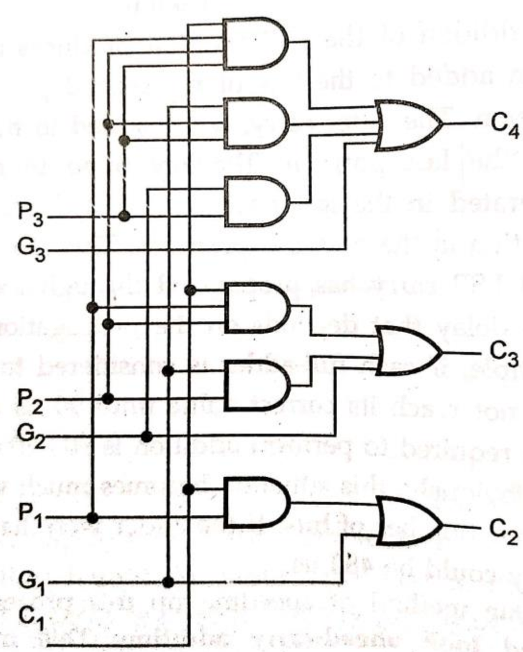


Fig. 2.11.2 Logic diagram of a look ahead carry generator

G_i is called a carry generate and it produces on carry when both A_i and B_i are one, regardless of the input carry. P_i is called a carry propagate because it is term associated with the propagation of the carry from C_i to C_{i+1}.

Now the Boolean function for the carry output of each stage can be written as follows.

$$C_2 = G_1 + P_1C_1$$

$$C_3 = G_2 + P_2C_2 = G_2 + P_2 (G_1 + P_1C_1) = G_2 + P_2G_1 + P_2 P_1C_1$$

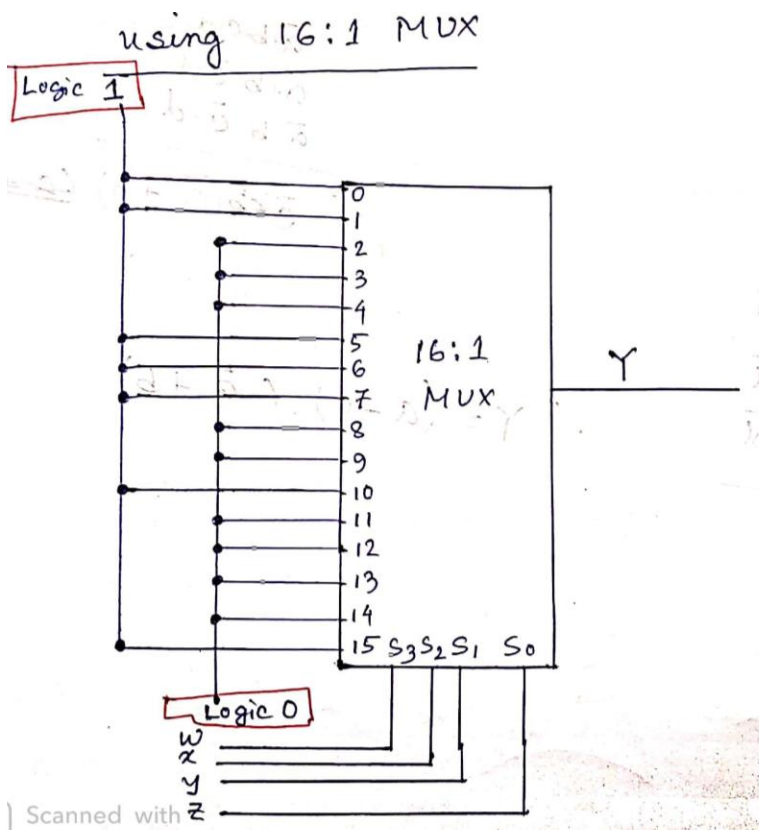
$$C_4 = G_3 + P_3 C_3 = G_3 + P_3 (G_2 + P_2 G_1 + P_2 P_1C_1)$$

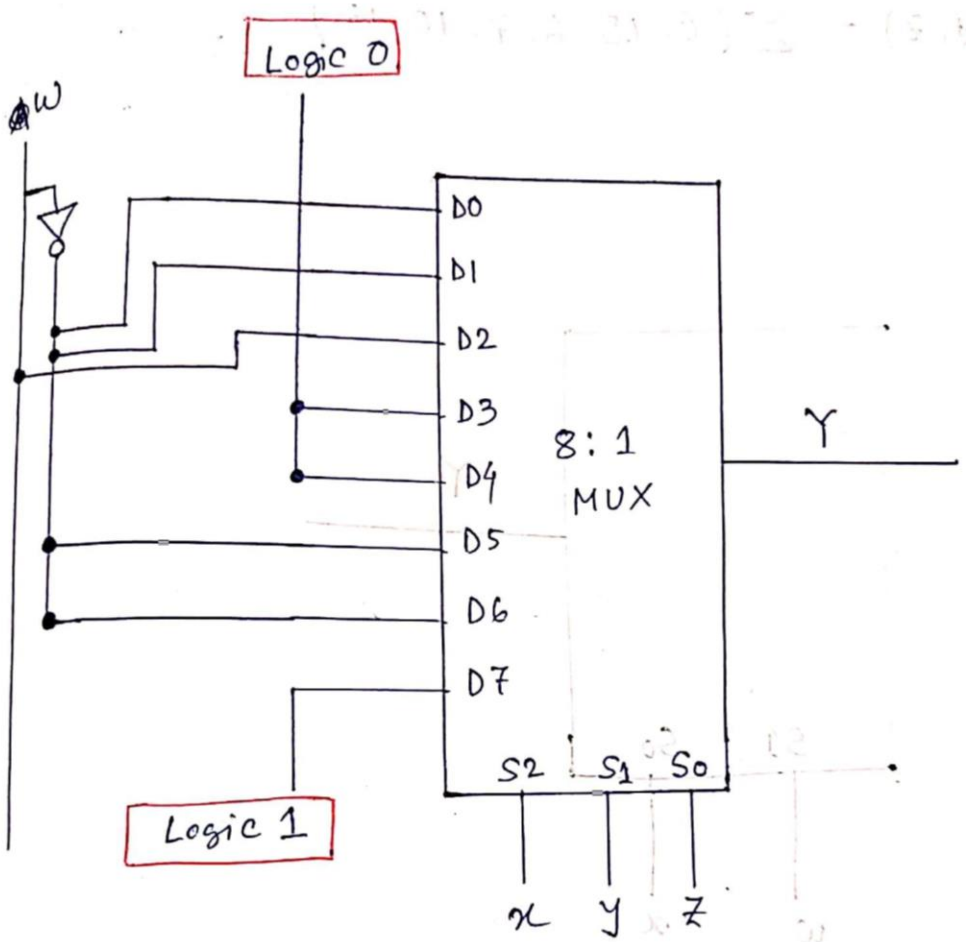
$$= G_3 + P_3G_2 + P_3 P_2 G_1 + P_3 P_2 P_1 C_1$$

From the above Boolean function it can be seen that C_4 does not have to wait for C_3 and C_2 to propagate; in fact C_4 is propagated at the same time as C_2 and C_3.

6. Realize the following Boolean function Y=f(w,x,y,z)=∑(0,1,5,6,7,10,15) using : i) 16 to 1 MUX ii)8:1 MUX iii)4:1 MUX.

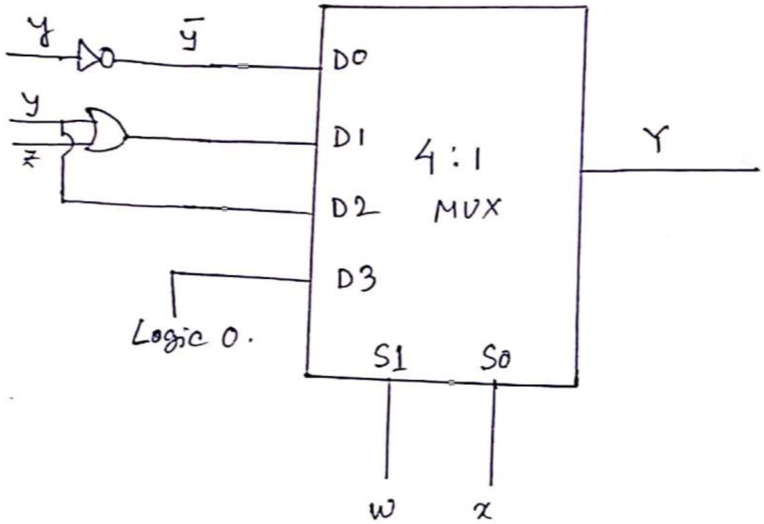
Solution:





	D0	D1	D2	D3	D4	D5	D6	D7
$\bar{w}$	0	1	2	3	4	5	6	7
w	8	9	10	11	12	13	14	15
	$\bar{w}$	$\bar{w}$	w	0	0	$\bar{w}$	$\bar{w}$	1

Using 4:1 MUX



	$\bar{y}\bar{z}$	$\bar{y}z$	$y\bar{z}$	yz	
D0	0	1	2	3	$\bar{y}\bar{z}+\bar{y}z = \bar{y}$
D1	4	5	6	7	$\bar{y}z+y\bar{z}+yz$
D2	8	9	10	11	$y\bar{z}+yz$
D3	12	13	14	15	0

$\therefore$ $D0 = \bar{y}$

$$D1 = \bar{y}z + y\bar{z} + yz$$
$$= \bar{y}z + y$$
$$= y + z$$

$$D2 = y\bar{z} + yz$$
$$= y$$

$D3 = 0$