Q2 - Determine the single bit error detection and correction for BCD No - 10110 with Odd Parity

Message = 10110

no. of message bit = n = 5

$2^k \geq k + n + 1$

$2^k \geq k + 5 + 1$

$2^k \geq k + 6$

$k = 4$

to satisfy the condition

D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9
P_1	P_2	n_1	P_3	n_2	n_3	n_4	P_4	n_5
P_1	P_2	1	P_3	0	1	1	P_4	0

$(P_1, D_3, D_5, D_7, D_9) = (P_1, 1, 0, 1, 0) = (1, 1, 0, 1, 0)$

$(P_2, D_3, D_6, D_7) = (P_2, 1, 1, 1) = (0, 1, 1, 1)$

$(P_3, D_5, D_6, D_7) = (P_3, 0, 1, 1) = (1, 0, 1, 1)$

$(P_4, D_9) = (P_4, 0) = (1, 0)$

Final Code

P_1	P_2	n_1	P_3	n_2	n_3	n_4	P_4	n_5
1	0	1	1	0	1	1	1	0

BCD - 1101

Unit - II

Minimization Techniques

There are two types of expression :-

i) SOP → Sum of Product → Min Term (m)

ii) POS → Product of Sum → Max Term (M)

$y = ABC + CA\bar{B}$ (Min Term)

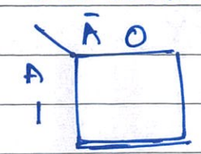
$y = (\bar{A} + \bar{B} + C)(A + \bar{B} + C)$ (Max Term)

Digit	Variable A B C	Min Term SOP (m)	Max Terms (POS) M
0	0 0 0	$\bar{A}\bar{B}\bar{C}$ =	
1	0 0 1	$\bar{A}\bar{B}C$ =	
2	0 1 0	$\bar{A}B\bar{C}$ =	
3	0 1 1	$\bar{A}BC$ =	
4	1 0 0	$A\bar{B}\bar{C}$ =	
5	1 0 1	$A\bar{B}C$ =	
6	1 1 0	$AB\bar{C}$ =	
7	1 1 1	ABC	

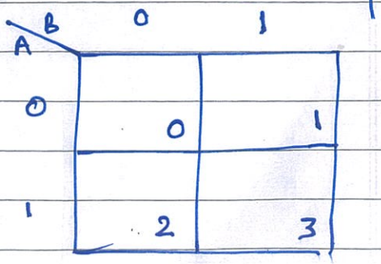
Digit	Variable A B C	MinTerms (SOP) (m)	MaxTerms (POS) (M)
0	0 0 0	$\bar{A}\bar{B}\bar{C} = m_0$	$(A+B+C) = N_0$
1		$\bar{A}\bar{B}C$	$(A+B+\bar{C})$
2		$\bar{A}B\bar{C}$	$A+\bar{B}+C$
3		$\bar{A}BC$	$A+\bar{B}+\bar{C}$
4		$A\bar{B}\bar{C}$	$\bar{A}+B+C$
5		$A\bar{B}C$	$\bar{A}+B+\bar{C}$
6		$AB\bar{C}$	$\bar{A}+\bar{B}+C$
7	1 1 1	$ABC = m_7$	$\bar{A}+\bar{B}+\bar{C} = N_7$

KMaps

i) One variable K-map



ii) Two variable K-map



Prakarsha

iii) Three variable K-map

A,B \ C	0	1
00	0	1
01	2	3
11	6	7
10	4	5

A \ B,C	00	01	11	10
0	0	1	3	2
1	4	5	7	6

iv) Four Variable K-map

A,B \ C,D	00	01	11	10
00	0	1	2	3
01	4	5	7	6
11	12	13	15	14
10	8	9	11	10

Minimization of equation

Q1. $Y = A\bar{B}C + \bar{A}\bar{B}C + \bar{A}BC + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C}$

Sol^n -

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

↳ SOP form

so, we use min term

$A\bar{B}C = 101 \rightarrow 5$

$\bar{A}\bar{B}C = 001 \rightarrow 1$

$\bar{A}BC = 011 \rightarrow 3$

$A\bar{B}\bar{C} = 100 \rightarrow 4$

$\bar{A}\bar{B}\bar{C} = 000 \rightarrow 0$

$\Rightarrow Y = \Sigma m(0,1,3,4,5)$

K-map of three variables

AB \ C	0	1
00	1 (0)	1 (1)
01	(2)	1 (3)
11	(6)	(7)
10	1 (4)	1 (5)

$\bar{A}C$

$\bar{B}$

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

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

Q2. $Y = \Sigma m(0,3,5,6,7,8,11,13,15)$

A,B \ C,D	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$	
$\bar{A}\bar{B}$	1 0	1	1 3	2	CD
$\bar{A}B$	4	1 5	1 7	1 6	$\bar{A}BC$
AB	12	1 13	1 15	14	BD
$A\bar{B}$	1 8	9	1 11	10	

$\bar{B}\bar{C}\bar{D}$

$Y = \bar{B}\bar{C}\bar{D} + \bar{A}BC + CD + BD$

Q3. $Y = \bar{A}BC + AB\bar{D} + ABCD$

Sol^n

$Y = \bar{A}BC \cdot 1 + AB\bar{D} \cdot 1 + ABCD$

$Y = \bar{A}BC(D+\bar{D}) + AB\bar{D}(C+\bar{C}) + ABCD$

$Y = \bar{A}BCD + \bar{A}BC\bar{D} + ABC\bar{D} + AB\bar{C}\bar{D} + ABCD$

$\bar{A}BCD = 0111 \rightarrow 7$

$\bar{A}BC\bar{D} = 0110 \rightarrow 6$

$ABC\bar{D} = 1110 \rightarrow 14$

$AB\bar{C}\bar{D} = 1100 \rightarrow 12$

$ABCD = 1111 \rightarrow 15$

$Y = \Sigma m(6,7,12,14,15)$

A,B \ C,D	00	01	11	10	
00	0	1	3	2	
01	4	5	1 7	1 6	BC
11	1 12	13	1 15	1 14	$AB\bar{D}$
10	8	9	11	10	

$Y = AB\bar{D} + BC$

Q4. $Y = \Sigma m(3,4,5,7,9) + d(1,6,11,13)$

↳ don't care

A,B \ C,D	00	01	11	10	
00	0	X 1	1 3	2	
01	1 4	1 5	1 7	X 6	$\bar{A}B$
11	12	X 13	15	14	$\bar{C}D$
10	8	1 9	X 11	10	

$\bar{B}D$

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

Q1. $Y = (\bar{A}+\bar{B}+C+D)(\bar{A}+\bar{B}+\bar{C}+D)(\bar{A}+\bar{B}+\bar{C}+\bar{D})$

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

POS

Sol -

$(\bar{A}+\bar{B}+C+D) = 1100 \rightarrow 12$

$(\bar{A}+\bar{B}+\bar{C}+D) = 1110 \rightarrow 14$

$(\bar{A}+\bar{B}+\bar{C}+\bar{D}) = 1111 \rightarrow 15$

$(\bar{A}+\bar{B}+C+\bar{D}) = 1101 \rightarrow 13$

$(A+B+\bar{C}+D) = 0010 \rightarrow 2$

$(A+\bar{B}+\bar{C}+D) = 0110 \rightarrow 6$

$(A+B+C+D) = 0000 \rightarrow 0$

$Y = \pi M(0,2,6,12,13,14,15)$

A,B \ C,D	00	01	11	10	
AB 00	0 0	1	3	0 2	$A+B+D$
$A\bar{B}$ 01	4	5	7	0 6	$A+\bar{C}+D$
$\bar{A}\bar{B}$ 11	0 12	0 13	0 15	0 14	$\bar{A}+\bar{B}$
$\bar{A}B$ 10	8	9	11	10	

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

Q2. $Y = (A+\bar{B}+D)(\bar{A}+B+C)$

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

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

$=$ POS

$A+\bar{B}+C+D$	$=$	0100	$= 4$
$A+\bar{B}+\bar{C}+D$	$=$	0110	$= 6$
$\bar{A}+B+C+D$	$=$	1000	$= 8$
$\bar{A}+B+C+\bar{D}$	$=$	1001	$= 9$

$Y = \pi M(4,6,8,9)$

A,B \ C,D	00	01	11	10	
00	0	1	3	2	
01	4	5	7	6	$A+\bar{B}+D$
11	12	13	15	14	
10	8	9	11	10	$\bar{A}+B+C$

$Y = (A+\bar{B}+D)(\bar{A}+BC$

Conversion of SOP to POS form

(a) $Y = ABC + \bar{A}BC$

SOP form

$\Rightarrow Y = ABC + \bar{A}BC$

$\Rightarrow \bar{Y} = \overline{(ABC + \bar{A}BC)}$

$\Rightarrow \bar{Y} = \overline{ABC} \cdot \overline{\bar{A}BC}$

$\Rightarrow \bar{Y} = (\bar{A}+\bar{B}+\bar{C}) \cdot (\bar{\bar{A}}+\bar{B}+\bar{C})$

$\Rightarrow \bar{Y} = (\bar{A}+\bar{B}+\bar{C})(A+\bar{B}+\bar{C})$ → POS form

(B) $Y = (A+\bar{B}+\bar{C}) \cdot (\bar{A}+B+C)$

POS form

$Y = (A+\bar{B}+\bar{C}) \cdot (\bar{A}+B+C)$

$\Rightarrow \bar{Y} = \overline{(A+\bar{B}+\bar{C}) \cdot (\bar{A}+B+C)}$

$\Rightarrow \bar{Y} = \overline{A+\bar{B}+\bar{C}} + \overline{\bar{A}+B+C}$

$= (\bar{A} \cdot \bar{\bar{B}} \cdot \bar{\bar{C}}) + (\bar{\bar{A}} \cdot \bar{B} \cdot \bar{C})$

$= (\bar{A} \cdot B \cdot C) + (A \cdot \bar{B} \cdot \bar{C})$

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

SOP form

KMap or Graphical Method

Minimize using quine mccluskey method or Tabular method

1) $Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + \bar{A}BCD + A\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D} + AB\bar{C}\bar{D} + AB\bar{C}D$

$\bar{A}\bar{B}\bar{C}\bar{D} = 0000 = 0$
$\bar{A}\bar{B}C\bar{D} = 0010 = 2$
$\bar{A}\bar{B}CD = 0011 = 3$
$\bar{A}BC\bar{D} = 0110 = 6$
$\bar{A}BCD = 0111 = 7$
$A\bar{B}\bar{C}\bar{D} = 1000 = 8$
$A\bar{B}C\bar{D} = 1010 = 10$
$AB\bar{C}\bar{D} = 1100 = 12$
$AB\bar{C}D = 1101 = 13$

$Y = \Sigma m(0,2,3,6,7,8,10,12,13)$

Table 1

Binary Term	Min Term
0	0000
2	0010
3	0011
6	0110
7	0111
8	1000
10	1010
12	1100
13	1101

Table 2

Binary Term	Min Term
(0,2)	00_0
(0,8)	_000
(2,3)	001_
(2,6)	0_10
(2,10)	_010
(3,7)	0_11
(6,7)	011_
(8,10)	10_0
(8,12)	1_00
(12,13)	110_

Table 3

Binary Term	MinTerm
(0,2,8,10)	_0_0
(2,3,6,7)	0_1_

Table 4

Prime Multiplicate		Binary Representation
$\bar{B}\bar{D}$	(0,2,8,10)	_0_0
$\bar{A}C$	(2,3,6,7)	0_1_
$A\bar{C}\bar{D}$	(8,12)	1_00
$AB\bar{C}$	(12,13)	110_

Table 5

Prime Implicate		m_0	m_2	m_3	m_6	m_7	m_8	m_{10}	m_{12}	m_{13}
$\bar{B}\bar{D}$	(0,2,8,10)	⊙	⊙				⊙	⊙		
$\bar{A}C$	(2,3,6,7)		⊙	⊙	⊙	⊙				
$A\bar{C}\bar{D}$	(8,12)						⊙		⊙	
$AB\bar{C}$	(12,13)								⊙	⊙

$Y = \bar{B}\bar{D} + \bar{A}C + AB\bar{C}$

Q. $Y(A,B,C,D) = \Sigma m\,(1,2,3,5,9,12,14,15) + \Sigma d\,(4,8,11)$

Minimize the expression using quine - Mccluskey Method

Sol- Table 1

Min Term	Binary Representation
1	0001
2	0010
3	0011
4	0100
5	0101
8	1000
9	1001
11	1011
12	1100
14	1110
15	1111

Table 2

Min Term	Binary Representation
1,3	00_1
1,5	0_01
1,9	_001
2,3	001_
3,11	_011
4,5	010_
4,12	_100
8,9	100_
8,12	1_00
9,11	10_1
11,15	1_11
12,14	11_0
14,15	111_

Tab. 3

Min Term	Binary Representation
(1,3,9,11)	-0-1

Tab 4

Primary Implicants: Expression	Minterm	Binary Representation
$\bar{B}D$	(1,3,9,11)	-0-1
$\bar{A}\bar{C}D$	(1,5)	0-01
$\bar{A}\bar{B}C$	(2,3)	001-
$\bar{A}B\bar{C}$	(4,5)	010-
$B\bar{C}\bar{D}$	(4,12)	-100
$A\bar{B}\bar{C}$	(8,9)	100-
$A\bar{C}\bar{D}$	(8,12)	1-00
ACD	(11,15)	1-11
$AB\bar{D}$	(12,14)	11-0

Table 5

Prime Implicate		m_1	m_2	m_3	m_4	m_5	m_8	m_9	m_{11}	m_{12}	m_{14}	m_{15}
$\bar{B}D$	(1,3,9,11)	⊙		⊙				⊙	⊙			
$\bar{A}\bar{C}D$	(1,5)	⊙				⊙						
$\bar{A}\bar{B}C$	(2,3)		⊙	⊙								
$\bar{A}B\bar{C}$	(4,5)				⊙	⊙						
$B\bar{C}\bar{D}$	(4,12)				⊙					⊙		
$A\bar{B}\bar{C}$	(8,9)						⊙	⊙				
$A\bar{C}\bar{D}$	(8,12)						⊙			⊙		
ACD	(11,15)								⊙			⊙
$AB\bar{D}$	(12,14)									⊙	⊙	
ABC	(14,15)										⊙	⊙

$Y = \bar{B}D + \bar{A}\bar{B}C + \bar{A}B\bar{C} + \bar{A}\bar{C}D + A\bar{B}\bar{C} + ACD + B\bar{C}\bar{D} + AB\bar{C}$

$\bar{B}D + \bar{A}\bar{B}C + \underline{\bar{A}\bar{C}D} + ABC + B\bar{C}\bar{D}$

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